RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

EDITOR

Howard P. Doub, M.D.
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The Osseous Lesions of Tuberous Sclerosis[1]

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Caro, Mich.

IT IS A GENERALLY accepted fact that there is a group of closely related congenital malformations which affect primarily ectodermal structures (skin, nervous system, etc.), but which may also present abnormalities in structures of mesodermal and, to a lesser degree, endodermal origin. Although not mutually exclusive in their manifestations, three syndromes in this group are particularly well defined and, as a result, have attracted most attention. They are (1) Recklinghausen's neurofibromatosis, (2) Bourneville's tuberous sclerosis, and (3) Sturge-Weber cephalotrigeminal angiomatosis. Each syndrome has fairly characteristic roentgenologic signs, which we have been trying to delineate more clearly by a systematic study of large series of patients with fairly typical clinical findings. By far the most fruitful site of roentgenologically demonstrable lesions to date has been the osseous system.

In 1948 Holt and Wright (1) published an analysis of the skeletal x-ray findings of 127 unequivocal cases of generalized neurofibromatosis seen at the University of Michigan Hospital between 1935 and 1947. Since that time, an additional 52 patients with neurofibromatosis have been studied at the same source, and it appears that scoliosis, erosive defects, disorders of growth, bowing and pseudarthrosis of tubular bones, intra-osseous cystic lesions, or a variety of other bony defects occur in approximately 30 per cent of these patients. With a few exceptions, this analysis is not unusual from the standpoint of the types of lesions encountered, but the incidence of these skeletal abnormalities was found to be far greater than the figure of 7 per cent widely quoted in the medical literature. In the light of this apparent discrepancy, it seemed reasonable to assume that osseous lesions in the other hereditary congenital ectodermoses might be more common than we have previously been led to believe, and this study of tuberous sclerosis was undertaken.

Although tuberous sclerosis was first recognized as a clinical syndrome by Bourneville (2), in 1880, it is of considerable interest that von Recklinghausen (3) reported a case in 1863, nineteen years before his classical description of the related syndrome of neurofibromatosis appeared. Tuberous sclerosis gets its name from the potato-like nodules occurring in the brain substance, which constitute the

[1] From the Department of Roentgenology, University of Michigan, and Caro State Hospital for Epileptics. Accepted for publication in June 1951.

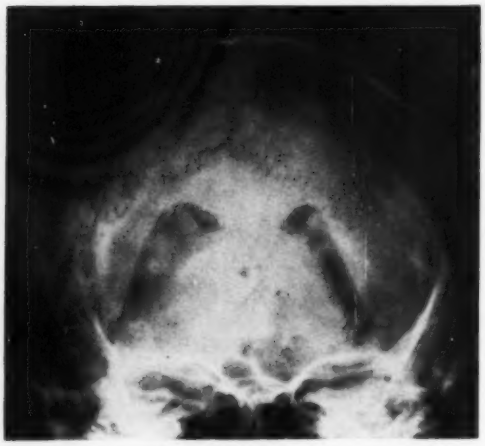

Fig. 1. Encephalogram of patient with tuberous sclerosis showing typical intraventricular protrusion of subependymal nodules, giving the "candle guttering" effect.

the nodules may calcify, particularly those in and about the basal ganglia.

Clinically, patients with classical tuberous sclerosis present the triad of facial adenoma sebaceum, mental deficiency, and convulsions. Retinal tumors (phakomas) are just as common as they are in the other congenital ectodermoses, and renal tumors of the mixed embryonal type occur in a large percentage of cases. The occasional manifestations of defective development and tumor or cyst formation in the lungs, heart, liver, adrenals, and other structures, lead to a wide variety of additional clinical findings which will not be considered in this paper. A more detailed description of the general clinical and pathologic manifestations of the disease has been presented previously (4).

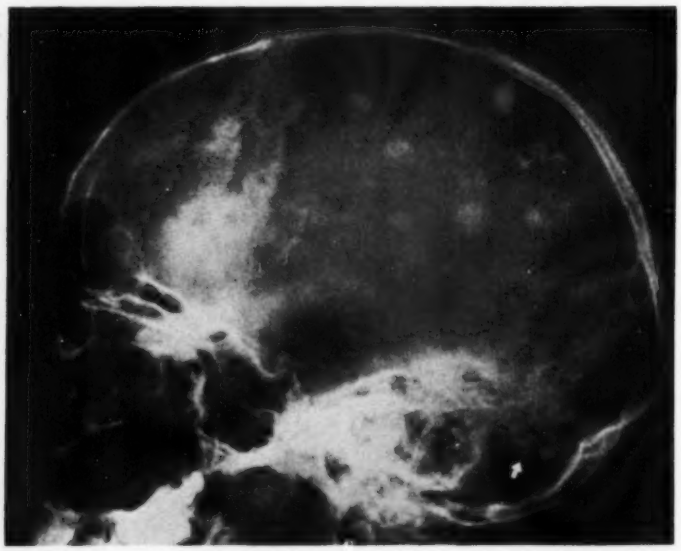

Fig. 2. Islands of sclerotic bone in calvarium of another patient with tuberous sclerosis. These plaques, located in the diploe, should not be mistaken for intracranial calcification, which also occurs in this disease. Arrow denotes calcification in dentate nuclei of the cerebellum.

basic pathologic lesions in the disease. Grossly these nodules are smooth, pearly white, relatively hard sclerotic patches that vary in size, shape, number, and distribution. They may project into the lateral ventricles, where they resemble wax candle gutterings (Fig. 1). Any of

Tuberous sclerosis is much less common than neurofibromatosis and it is therefore difficult to accumulate a sizable group of patients with this disorder, especially in its "pure" form, for adequate roentgenologic study. For example, during a period in which approximately 180 patients with

neurofibromatosis were seen at University Hospital, only 10 accurate diagnoses of tuberous sclerosis were made. It has been our good fortune, however, to have available for study a group of 33 additional patients at Michigan State Hospital for other publications. The only observations of special note were that three of the patients presented calcification in the dentate nuclei of the cerebellum, while another had typical wavy angiomatous calcification in one occipital pole of the

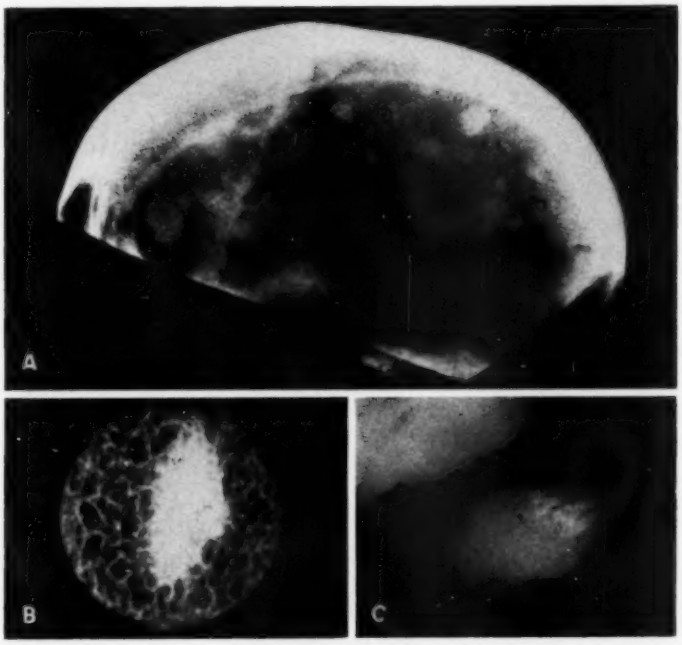

Fig. 3. A. Postmortem roentgenogram of calvarium of patient shown in Figure 2. The fact that the brain has been removed proves unequivocally that the islands of increased density are within the calvarium. B. Detail view of one of the sclerotic plaques. *Pathologist's Report:* "The dense patches in this bone were areas of osteosclerosis, in which the marrow spaces of the cancellous bone had largely disappeared, owing to a concentric development of bone on the previous trabeculae. There was no evidence of neoplasm. It was evident that in the region of osteosclerosis the marrow was fatty instead of cellular. I am not prepared to make any suggestion as to why one region rather than another, was selected for the change."—C. V. Weller, M.D.

C. Postmortem roentgenogram of cerebellum clearly showing the pattern of calcification in dentate nuclei poorly delineated in Figure 2.

Epileptics (Caro), who along with the 10 cases mentioned above make a total series of 43.

Unquestionably, tuberous sclerosis is best known among roentgenologists as an important cause of intracranial calcification, especially in the region of the basal ganglia. At least 50 per cent of the patients in this group had such calcification, and it was similar in appearance and distribution to that described in numerous brain identical to that seen in the Sturge-Weber syndrome.

It is becoming more widely recognized that many of the areas of apparent intracranial calcification in tuberous sclerosis actually represent sclerotic plaques in the cranial vault, as reported by Dalsgaard-Nielsen (6) and Gottlieb and Lavine (7). Although at least one subsequent report (8) has indicated that these skull lesions are areas of hyperostosis on the inner table

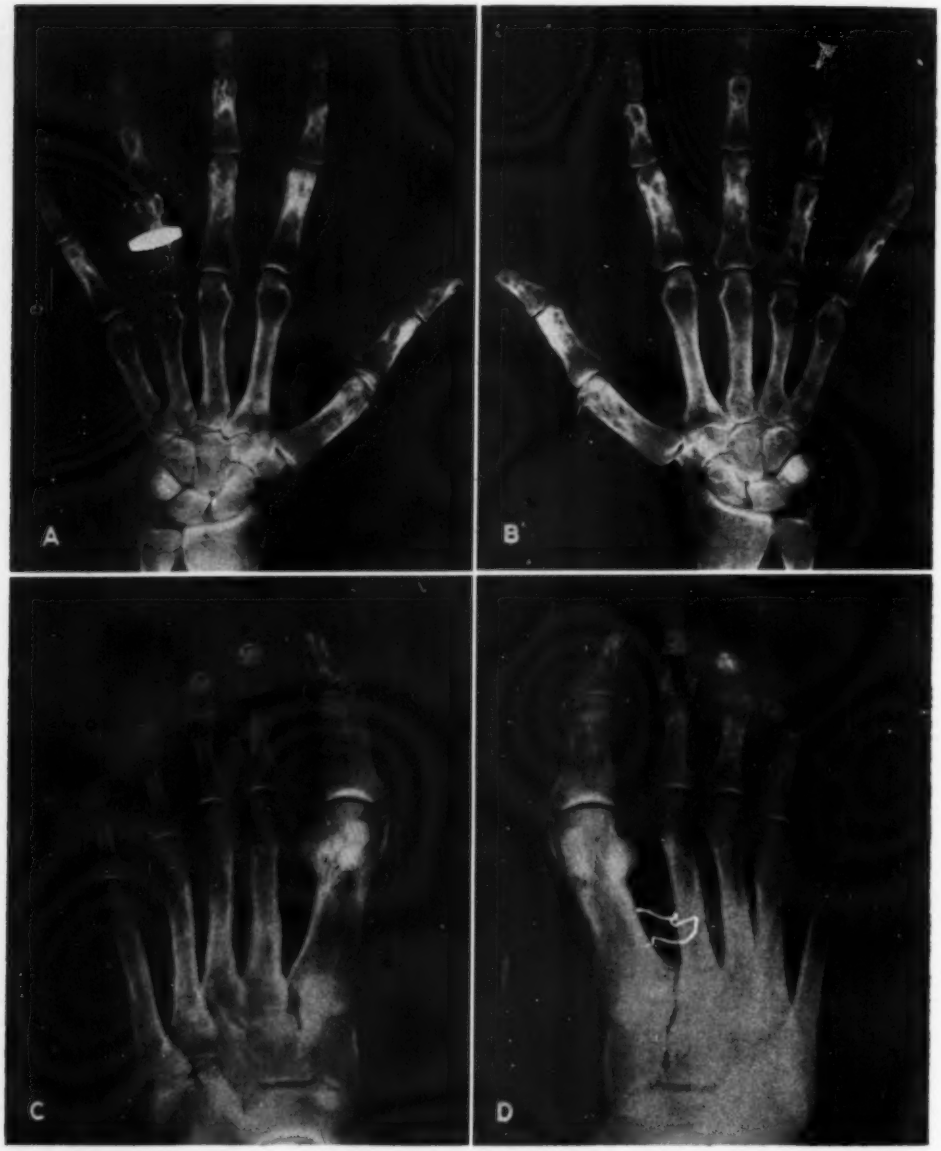

Fig. 4. Hands and feet of young woman with classical clinical triad of tuberous sclerosis. The pseudocystic lesions in the phalanges, the wavy periosteal proliferation of the metatarsals and metacarpals, and the somewhat smeared appearance of the bone trabeculae constitute a fairly diagnostic roentgenographic picture.

Similar changes were observed in 20 other patients with tuberous sclerosis.

of the vault immediately adjacent to brain nodules, such is not invariably the case. In 2 cases in this group coming to autopsy, previously reported by Dickerson (5), numerous sclerotic foci found in the skull were largely confined to the diploe (Figs. 2 and 3).

Forty of the 43 patients in our series had satisfactory skull films, and at least 17, or 40 per cent, had abnormal islands of

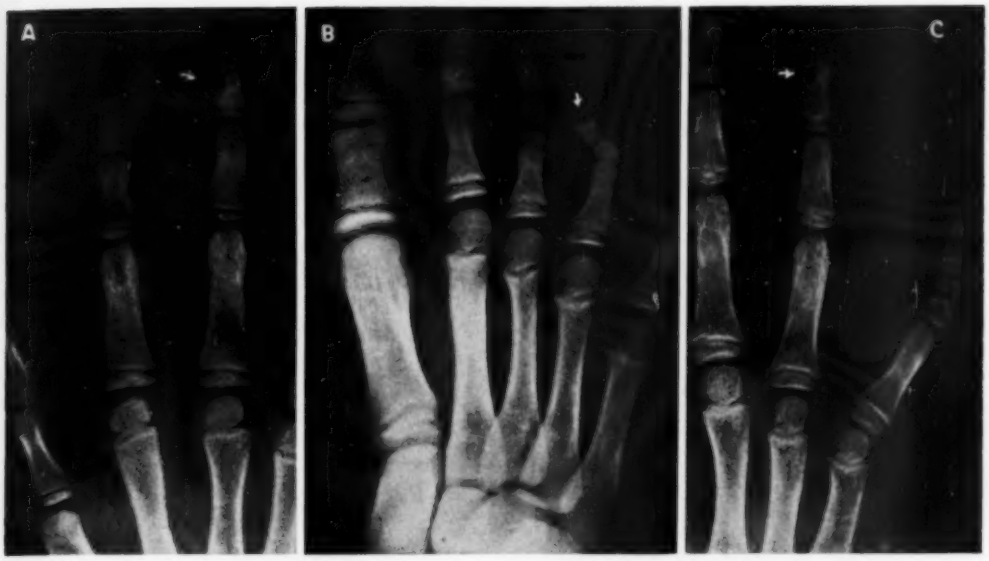

Fig. 5. Osseous lesions of tuberous sclerosis in children. A and B. Twelve-year-old boy with isolated defects in distal phalanges of right third finger and right second and fourth toes. Although these lesions have the appearance of superficial erosions, a thin line of cortical bone completely encircles them. C. Eleven-year-old patient with solitary "cystic" lesion of distal phalanx of fourth finger. An interesting incidental finding is the short middle phalanx of the fifth finger, most often associated with mongolian idiocy. This particular patient did not have mongolism.

sclerotic bone in the cranial vault. Several others had very suggestive areas of sclerosis, but these were not included.

One can find in the voluminous literature on tuberous sclerosis numerous references to lesions in the bones of the hands and feet, but in only a few scattered case reports are roentgenograms of these lesions reproduced (7–10). Curiously enough, none of the illustrated articles is found in the radiologic literature. Furthermore, it appears that no attempt has been made to determine the incidence of these lesions and no definite statement has been made regarding the specificity of the roentgen findings. Our investigation is primarily concerned with these features of the disease.

Thirty of our 43 patients had x-ray examination of the hands and/or feet, and no less than 20 (66 per cent) of this group had definite roentgenologic changes, consisting of cyst-like foci in the phalanges and a rather distinctive type of periosteal new bone formation along the shafts of the metatarsals and the metacarpals, as originally described by Gottlieb and Lavine. It was of interest that the cystic areas were more common in the hands, whereas the periosteal changes displayed a distinct predilection for the metatarsals (Fig. 4).

The cyst-like lesions, in general, are not sharply circumscribed or "punched-out," but rather seem to be formed by slowly progressive rearrangement of the trabeculae, which in turn may coalesce, producing the "smeared," sclerotic appearance shown in Figure 4. On the basis of observations on the very few young children in this series, it appears that the "cystic" foci are not present at birth but may appear relatively early in childhood (Fig. 5). Undoubtedly, some of the lesions are first seen in adult life and gradually increase in size and number over a period of many years (Fig. 6). To date we have been unable to obtain biopsy material for histologic examination, but it seems reasonable to speculate that the bone cysts are not cysts at all, in the true sense of the

word. They probably represent areas of non-specific fibrous replacement similar to that found in the transient cortical defects of growing tubular bones and certain "cystic" forms of neurofibromatosis of bone (1).

The periosteal thickening found in so many of these patients with tuberous sclerosis is in most instances of a wavy, irregular type. In some patients it manifests itself as localized mound-like excrescences along the shafts of the involved bones. As already indicated, this periosteal reaction is much more common in the metatarsals than in the metacarpals; very seldom is it observed in the phalanges. The reason for this selectivity of involvement is just as obscure to us as is the localization of the cyst-like lesions in the phalanges. Regardless of the cause, however, it seems reasonable to suggest that the combination of these findings represents a fairly diagnostic roentgen appearance.

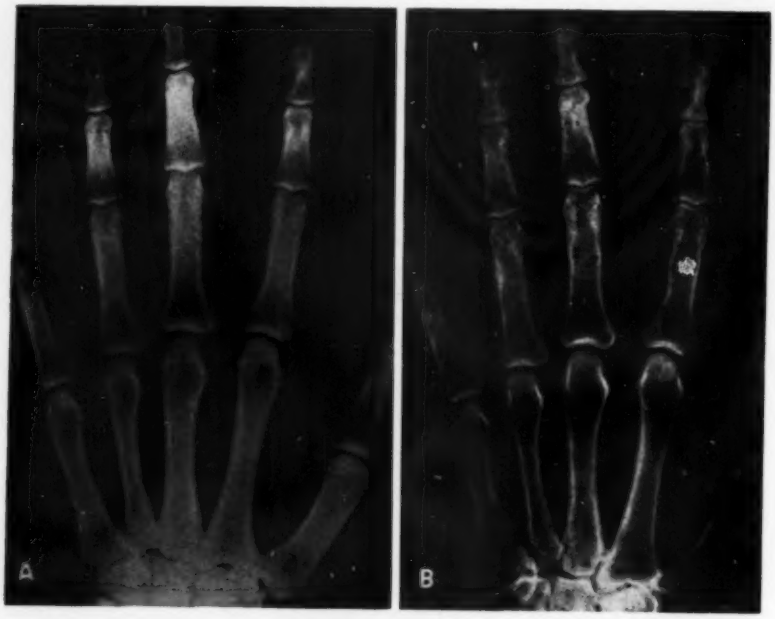

Fig. 6. A. Left hand of young man with tuberous sclerosis. This film, obtained in 1940, shows little evidence of abnormality. B. Ten years later there are pronounced generalized osteoporosis, distortion of trabeculae, and pseudocysts.

In view of the accepted relationship between tuberous sclerosis and neurofibromatosis, and the high incidence of defects of the spine and long bones in the latter disease, it appeared likely that similar defects would be found in our patients with tuberous sclerosis. It should be mentioned in this connection that Ackermann (11) and, more recently, Budenz (12) have reported isolated cases of what they consider to be tuberous sclerosis with spectacular skeletal abnormalities of the type more commonly associated with neurofibromatosis. A survey of our patients with tuberous sclerosis revealed no such abnormalities. Conversely, a review of available roentgenograms of 179 patients with neurofibromatosis disclosed no examples of cystic lesions in the phalanges and no periosteal thickening of the metatarsals, although such abnormality was observed occasionally in the long tubular bones.

DIFFERENTIAL DIAGNOSIS

From a purely objective roentgenographic point of view the cyst-like lesions of

the phalanges in tuberous sclerosis closely resemble the osseous lesions of sarcoidosis, but certain differential features are evident. The fine reticular pattern of bone destruction so characteristic of sarcoid is not found in tuberous sclerosis; there is less distortion of the general trabecular pattern in localized sarcoid lesions and, above all, sarcoidosis almost never produces associated periosteal thickening. Entire phalanges may be destroyed without the slightest evidence of subperiosteal new bone formation. Furthermore, when phalangeal lesions are found in tuberous sclerosis, cranial plaques or intracranial calcification, or both, will almost invariably be present. Such cranial abnormalities do not ordinarily occur in sarcoidosis.

The degenerative cyst-like lesions commonly associated with the chronic arthritides might conceivably be confused with the phalangeal lesions of tuberous sclerosis, but associated joint changes in the former should serve to differentiate them.

Diffuse, uniform, reactive periosteal new bone formation of the metatarsals occurs frequently in patients with localized disorders of the feet due to arch defects, faulty weight-bearing, etc. It should be emphasized, however, that the periosteal thickening in tuberous sclerosis is more often of a localized nature or, if extensive, of an irregular wavy variety.

Low-grade inflammatory lesions of the metatarsals may simulate the periosteal thickening of tuberous sclerosis, but other roentgenologic as well as clinical signs of an infectious process will serve to make the differentiation. Callus formation in so-called march fractures might occasionally be confusing.

SUMMARY

A roentgenologic survey of 43 patients with well defined tuberous sclerosis has shown skeletal abnormalities which, though less diversified than those in neurofibromatosis, are even more common and certainly more diagnostic in their roentgenographic appearance. Forty per cent of 40 patients with satisfactory skull films had scattered sclerotic plaques in the cranial vault and 66 per cent of the 30 patients who had roentgen examination of the hands and feet showed localized cyst-like areas of bone destruction in the phalanges and/or wavy periosteal new bone formation along the shafts of the metatarsals and metacarpals. Although difficult to explain on the basis of rational medical reasoning, these highly selective osseous lesions in the extremities are so strikingly similar to each other and to the few scattered illustrations in the medical literature that they may be considered valuable aids in the diagnosis of tuberous sclerosis. As such, they deserve more attention than they have been accorded in the past.

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SUMARIO

Las Lesiones Oseas de la Esclerosis Tuberosa

Un estudio roentgenológico de 43 enfermos que padecían de esclerosis tuberosa bien definida reveló anomalías óseas que, aunque menos variadas que las de la neurofibromatosis, son hasta más frecuentes y ciertamente más diacríticas en su aspecto radiográfico. Cuarenta por ciento de 40 enfermos para los que había satisfactorias radiografías del cráneo tenían placas escleróticas en la bóveda craneal, y 66 por ciento de los 30 cuyas manos y pies fueron objeto de estudio roentgenológico mostraron zonas quistoideas de osteólisis en las falanges y/o neoosteogenia ondulante en el periostio a lo largo de las diáfisis de los metatarsianos y metacarpianos. Aunque parece difícil explicarlo a base de lógico razonamiento médico, esas lesiones óseas tan selectivas en los miembros guardan tan estrecho parecido entre sí y con las pocas radiografías esparcidas por la literatura médica que cabe considerarlas como valiosos auxiliares en el diagnóstico de la esclerosis tuberosa. En esa capacidad, son acreedoras a más atención que la que han recibido en el pasado.

Dental Roentgenologic Manifestations of Systemic Disease

I. Endocrine Disturbances[1]

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Rochester, Minn.

THE endocrine glands which are known to have an influence upon the skeleton are the pituitary, thyroid, parathyroid, adrenal, and sex glands. Any quantitative change in the hormones secreted by these glands, be it underproduction or overproduction, may lead to disturbances of growth and metabolism of bones. The teeth and jaws reflect endocrine dysfunction just as do other parts of the skeleton, and the dental effects may remain as a permanent record of the disorder.

Any influence that endocrine dysfunction may have upon the teeth themselves is almost entirely limited to the period of their development and is manifested by either retardation or acceleration of development and eruption, or by faulty and imperfect structural development. Defects which occurred in the incisor teeth of rats deprived of their parathyroid glands first led Erdheim (1), in 1911, to the realization that secretion from these glands has an influence upon calcium metabolism.

In general, the size of the teeth is not altered in endocrine disturbances. Dwarfs do not have dwarfed teeth, nor are the teeth of the giant necessarily larger than those which might well be seen in persons of normal size. Teeth in which calcification has been completed prior to the onset of the disturbance are unaffected. Hard tooth structure undergoes no demineralization or hypercalcification; therefore, there is no change in radiographic density. Thus the teeth can serve as a gauge of density or as a penetrometer to aid in the recognition of cases in which skeletal complications are present.

Effects of endocrine disturbances upon the bone of the jaws are in a large measure similar to those on other bones of the skeleton. Disturbances which occur during the period of growth and development may be manifested by retardation and underdevelopment or by acceleration and overdevelopment of the jaws. In instances in which overdevelopment of the skeleton occurs, the mandible, because of the normal persistence of growth cartilage of the condyle, is prone to undergo relatively greater enlargement than the majority of the other bones.

Where the structure or quality of the bone is altered, the intra-oral dental roentgenogram is of value, for it often reveals minimal distortion of trabecular pattern and mild demineralization in instances in which it may not be demonstrable in other roentgenograms. One of the changes which may take place in case of demineralization is the obliteration or disappearance of the lamina dura, the uniform radiopaque line which represents the alveolar socket. This observation has been made use of in the diagnosis, notably, of hyperparathyroidism. It is not, however, peculiar to hyperparathyroidism, but is seen also in several other conditions in which there are associated demineralization and osteoporosis, among them, Cushing's syndrome, sprue, vitamin D deficiency, and Paget's disease.

The chronologic age for the beginning of calcification and completion of enamel and dentine formation, as well as eruption of individual teeth, has been fairly well established by Logan and Kronfeld (2) and others. A chart prepared by Schour and Massler (3) showing development of human dentition is reproduced in Figure 1. With the exception of some rare and un-

[1] From the Section on Dentistry, Mayo Clinic, Rochester, Minn. Presented in part at the Thirty-seventh Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1951.

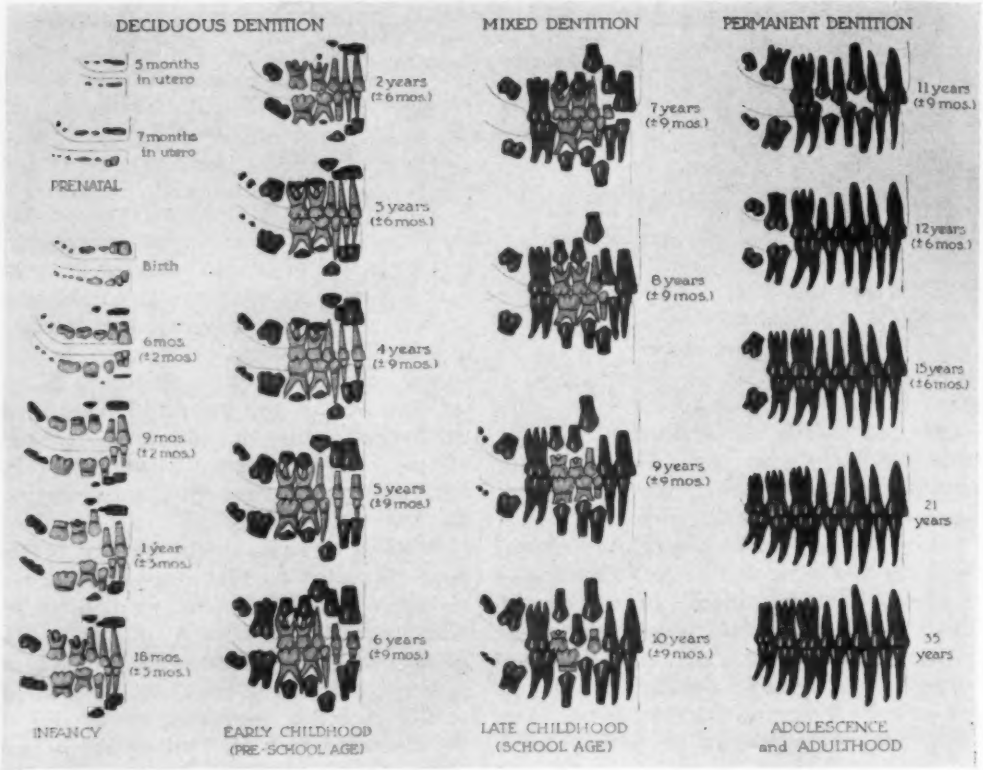

Fig. 1. Chart showing development of human dentition. (This chart is reproduced by permission of the authors and publisher. It is the second edition of one which originally appeared in Schour and Massler: The Development of the Human Dentition. J. Am. Dent. A. 28: 1153–1160, July 1941.)

usual anomalous conditions which are peculiar to the teeth, their development generally conforms to chronologic skeletal development. Therefore, the degree of dental development can, in a measure, be used as an index in determining the approximate skeletal age, much as the number of calcification centers in the wrist is an index of the degree of skeletal development.

Abnormality in the development of the teeth as revealed by the roentgenogram is of more significance than the time of their eruption, since eruption may be impeded by lack of growth or by quality of bone of the alveolar process. In estimating the age of dental development the third molars should be disregarded, since their time of development is variable and often retarded with no apparent systemic basis.

In the following discussion, there have been selected for illustration dental roentgenograms that were made for persons suffering from disturbances of the pituitary, thyroid, parathyroid, adrenal glands, and pancreas. To conserve space, some of the illustrations have been reduced from a sixteen- to a ten-film mount, when, by so doing, the condition could be illustrated adequately. In most instances, illustrations have been selected from those available demonstrating the extreme variations from normal, with the realization that each variation is by no means present in all cases. It must also be realized that a single illustration does not present the complete roentgenographic picture of any one entity, since this picture may vary appreciably, depending upon whether the condition is in the early or advanced

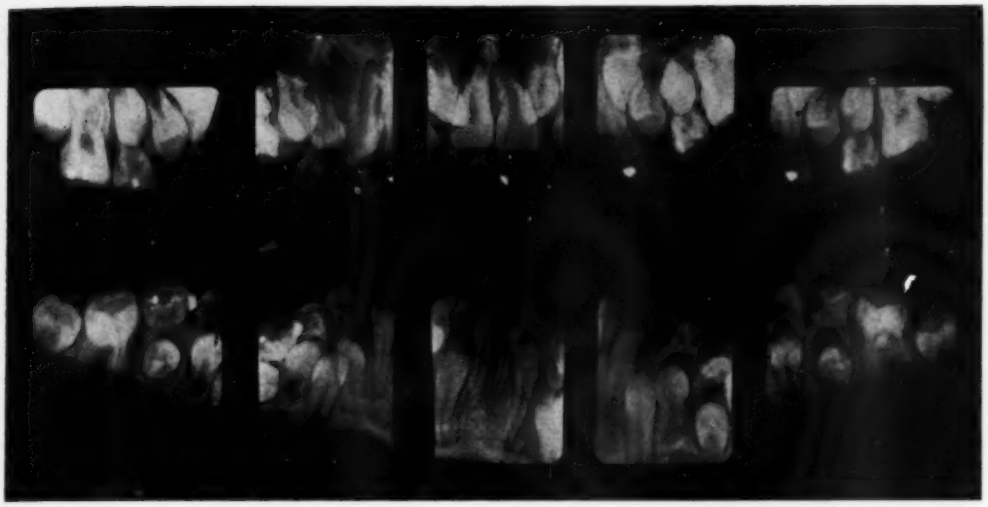

Fig. 2. Hypopituitarism in girl aged twelve and a half years. The jaws are small and underdeveloped. Dental development and eruption are retarded. The dental age is approximately that of a child seven years of age.

stage, or upon its severity and degree of involvement. Also, a characteristic roentgenographic picture of a disease may have been altered as a result of therapeutic measures. Since many endocrine disturbances are amenable to treatment in varied degrees, these alterations are not an uncommon finding.

PITUITARY GLAND

Hypopituitarism: In the event that hypopituitarism has its onset in infancy, the growth of the jaws is retarded, and they are underdeveloped. This underdevelopment is in general not disproportionate to that of the remainder of the skeleton. The size of the teeth is not affected, though their growth and development are retarded, as is the time of eruption.

The dental roentgenogram shown in Figure 2 is that of a pituitary dwarf at the age of twelve and a half years. Almost all of the available space in the small underdeveloped jaws is occupied by teeth of normal size, none of which in the permanent series is absent. Most of the teeth of the primary series are still present, and the permanent mandibular central incisors, which erupt normally at six to seven years of age, are now undergoing eruption. Formation of the enamel of the first premolars, which is usually complete at about six years of age, has been completed only recently. Dental development is approximately six years behind the chronologic age. The carpal development was that of a seven-year-old child, the dental and carpal age being approximately the same.

Hyperpituitarism: An overproduction of the growth hormone from the pituitary gland produces an overgrowth of those parts of the body which are still capable of growth at the time of onset of the hypersecretion. Regardless of the time of onset of hyperfunction, the crowns of the teeth are of normal size, since their growth pattern is invariably already established. In certain instances, however, there may be some degree of enlargement of the roots as a result of hypercementosis, for cementum normally tends to be deposited throughout life.

One of the central features of hyperpituitarism is the marked enlargement of the mandible (4). Even in giantism, in which overgrowth of the skeleton is relatively uniform, the mandible undergoes disproportionate enlargement, particularly

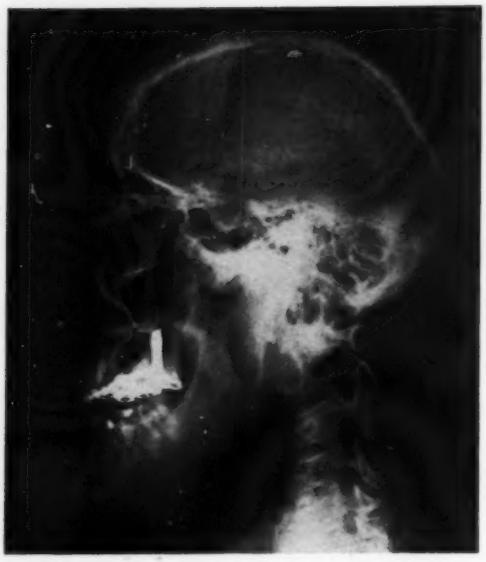

Fig. 3. Hyperpituitarism (giantism). Lateral view of the head showing disproportionate overgrowth of the mandible as compared to the other bones of the head. Functional occlusion had been remarkably well restored by means of a prosthetic appliance made by the patient's dentist.

when hyperactivity of the gland tends to persist into adult life.

Giantism: When onset of hypersecretion occurs prior to the age of five or six years, there is a fairly uniform overgrowth of all parts of the body, and the result is a person who is fairly well proportioned but of abnormally large stature. One of the parts which may undergo disproportionate overgrowth is the mandible. This is apparent in the lateral view of the head, shown in Figure 3. It reveals a large prognathous mandible which has undergone appreciably greater enlargement than have the other parts of the head. The dental roentgenograms for the same person are shown in Figure 4. These were made on standard-size dental films. The trabecular pattern is normal, with no appreciable increase in radiographic density of the bone. There is an abnormal spacing of the anterior teeth, particularly in the mandible. The spacing of the maxillary teeth can be partly accounted for by the congenital absence of the second premolars. The crowns of the teeth are of normal size. The roots of the posterior teeth are large in proportion to the crowns and this increase in size can be attributed partly to hypercementosis.

Acromegaly: In acromegaly, the greatest amount of overgrowth occurs in the terminal parts of the body—fingers, toes, nose, and skull. Cellular activity appears to be greater at the sites of formation of endochondral bone. There is a great increase in length of the ramus of the mandible as a result of endochondral ossification of the condyle. This leads to supra-eruption of the teeth, followed by an apposition of bone at the alveolar crest which increases the height of the mandibular body. The result is a marked

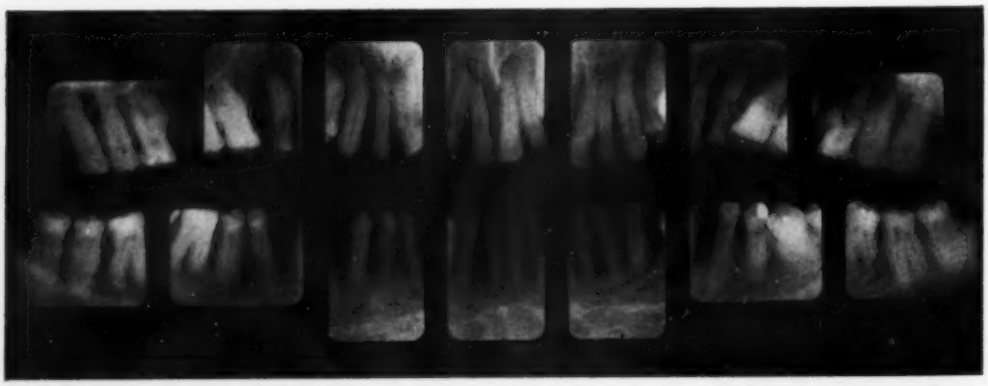

Fig. 4. Hyperpituitarism (giantism). Dental roentgenogram for case shown in Figure 3, demonstrating abnormal spacing of the anterior teeth. The crowns of the teeth are normal in size. The roots of the posterior teeth are abnormally large in proportion to the crowns.

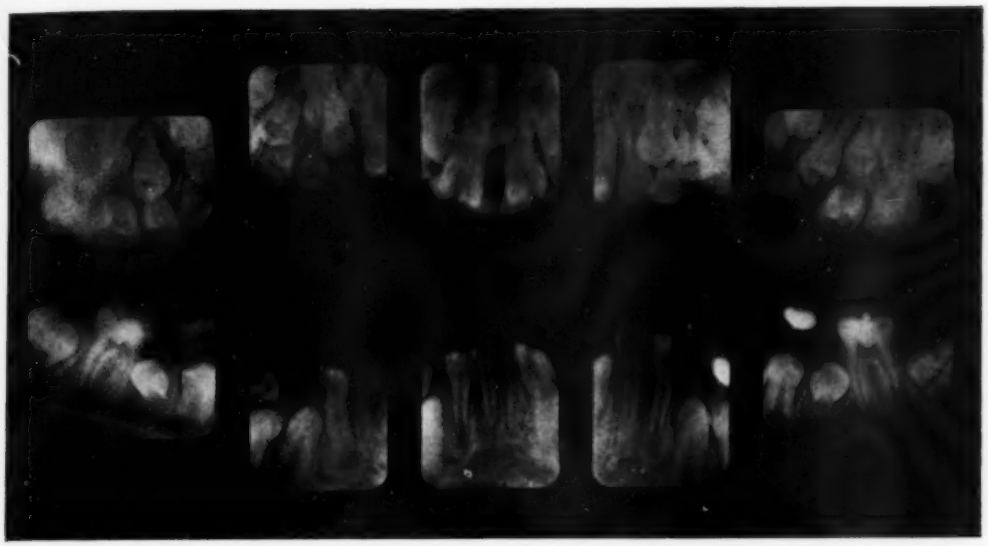

Fig. 5. Hypothyroidism (cretinism). Dental roentgenograms of a girl thirteen and a half years of age. Development and eruption of the teeth correspond approximately to those of a child aged six to seven years. (Reproduced, with permission, from Stafne, E. C.: Dental Roentgenologic Aspects of Systemic Disease. J. Am. Dent. A. **40:** 265–283, March 1950.)

enlargement of the entire mandible and a decided prognathism. Mortimer, Levene, and Rowe (5) made roentgenograms of a series of museum acromegalic crania in all of which lateral views demonstrated mandibular enlargement and prognathism. There is a formation of spaces between the teeth of both jaws, with an outward tilting of the teeth which is produced by abnormal pressure and stress of macroglossia. According to Korkhaus (6), this is one of the most reliable symptoms of acromegaly and serves to differentiate it from anomalous mandibular protrusions which are of genetic and hereditary origin.

Because of the abnormal amount of bone present in the mandible, there is an increased radiographic density. The trabecular pattern, however, is not altered; therefore, the dental roentgenogram is of diagnostic value only in that it serves to rule out tumors, Paget's disease, and other conditions that may produce abnormal enlargement of the jaws.

THYROID GLAND

Hypothyroidism: Only hypothyroidism which is present at birth or has its onset during infancy or early childhood has an effect upon the jaws and teeth. This is manifested by small and underdeveloped jaws, retarded shedding of the primary teeth, and delayed eruption of the permanent teeth. The size and form of the teeth are not affected. The degree of retardation depends upon whether or not thyroid therapy has been instituted and on its success. The teeth of even successfully treated patients may not attain normal development, but the response is favorable.

The dental roentgenogram shown in Figure 5 is that of a girl thirteen and a half years of age who was suffering from hypothyroidism. Of the primary teeth, three of the molars had been lost from caries, the mandibular central incisors had undergone normal shedding, and the others were still in place. Of the permanent teeth, the premolars had undergone calcification, which is normally attained at about seven years of age. The stage of eruption of the permanent teeth corresponds to that of a child of six to seven years. Carpal development according to Todd's standards had reached approximately the same age.

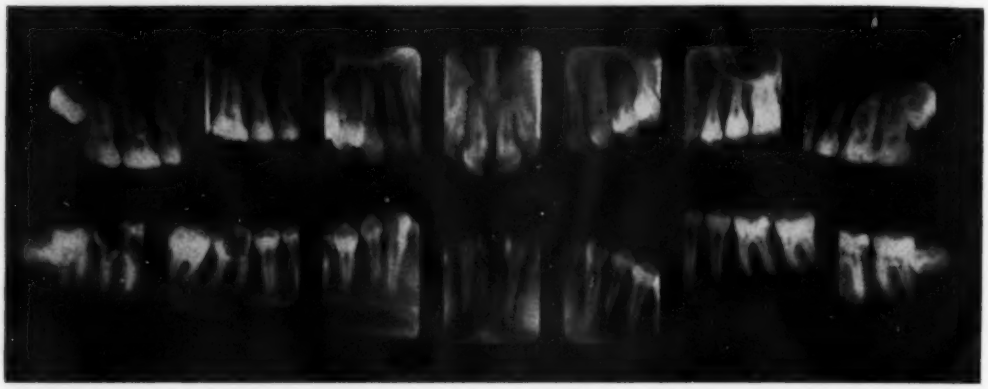

Fig. 6. Hyperthyroidism. Roentgenogram made for a girl twelve years of age showing uniform osteoporosis of both jaws. Teeth had erupted early. Dental development was at least two years premature, as evidenced by completed root formation of the second molars. (Reproduced, with permission, from Stafne, E. C.: Dental Roentgenologic Aspects of Systemic Disease. J. Am. Dent. A. 40: 265–283, March 1950.)

Hyperthyroidism: Hyperthyroidism, having its onset in childhood, may, in contrast to hypothyroidism, accelerate skeletal growth, including development and eruption of teeth. Middleburgh (7) has reported the eruption of the maxillary central incisors and first molars and the mandibular incisors at the age of four years and eleven months. Welti (8) reported a case of hyperthyroidism in a child five years of age in whom the dentition corresponded to that of a child of nine. That there may be an associated osteoporosis is suggested by the roentgenogram shown in Figure 6, made for a girl twelve years of age who had hyperthyroidism. An exact record of the time of eruption of the teeth could not be elicited; the second molars, however, had erupted at ten years of age, and the fact that their roots were fully formed at twelve years suggests that the development and eruption had occurred at least two years prematurely. The roentgenograms revealed a uniform osteoporosis throughout both jaws. In view of this, it is interesting to note that the teeth are normal as to form and size and relatively free from caries, the mandibular left first molar being the only carious tooth present.

An attempt has been made to evaluate the degree of osteoporosis in instances in which it is associated with toxic goiter. However, the degree of osteoporosis as revealed by the dental roentgenogram is rarely sufficient to be of diagnostic value.

PARATHYROID GLANDS

Hypoparathyroidism: Hypoparathyroidism, when it has its onset early in life, produces a hypocalcemia which not only has an effect upon the rates of dental development and eruption, but upon structural development as well. The central feature of interference with dental development is hypoplasia of enamel. One must keep in mind, however, that hypoplasia of enamel may result from hypocalcemia other than that associated with parathyroid insufficiency (9). Albright and Strock (10) have observed that hypoplasia of dentin may also occur, and this is evidenced by short underdeveloped dental roots.

The dental roentgenogram which was made for a girl seventeen years of age who was suffering from hypoparathyroidism and which demonstrates hypoplasia of enamel is shown in Figure 7. The dental findings in this case have been previously reported by Lovestedt (11). The roentgenogram reveals a hypoplasia of enamel of the premolars and second and third molars. The first evidence of calcification of the premolars normally appears at approximately two years of age, that of the

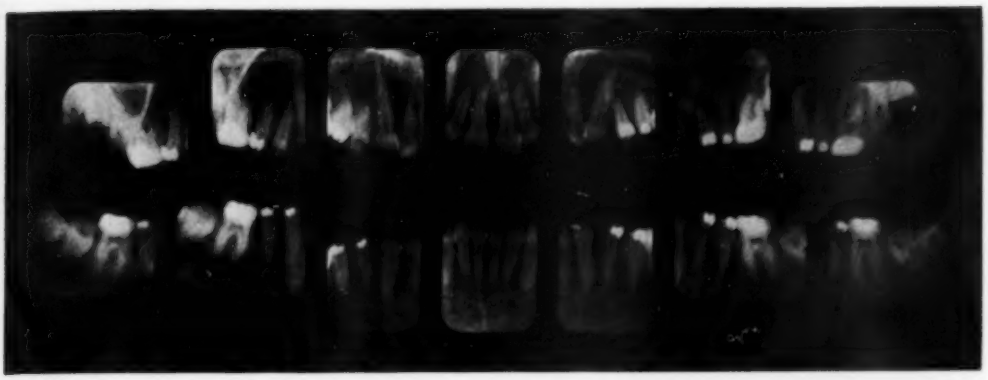

Fig. 7. Hypoparathyroidism. Roentgenogram showing hypoplasia of the enamel of all premolars and the unerupted second and third molars; all these are teeth in which the pattern of enamel formation is established at two years of age and later. Other teeth are unaffected. The defects of enamel suggest that the disease had its onset at two to three years of age. (Reproduced, with permission, from Stafne, E. C.: Dental Roentgenologic Aspects of Systemic Disease. J. Am. Dent. A. **40:** 265–283, March 1950.)

molars later. The enamel defect in the molars in this instance is more extensive than that of the premolars. The second molars, for which the normal time for eruption is approximately twelve years of age, had not erupted. Skeletal development was comparable to that of an eleven-year-old child. There was also calcification of cerebral basal ganglia, which, according to Camp (12), is a significant finding in the diagnosis of hypoparathyroidism.

Hyperparathyroidism: When skeletal features of hyperparathyroidism are present, the jaws are invariably involved. In instances in which there is minimal disease of the bone the dental roentgenogram has particular value. Keating (13) states: "The technical superiority of roentgenograms of the bone surrounding the teeth, plus the special advantage provided by the teeth as a gauge of density, make dental roentgenograms particularly useful in the recognition of mild degrees of skeletal involvement."

Roentgenographic evidence of the disease is characterized by decreased radiographic density and by transformation of normal trabecular pattern to fine lace-like trabeculae. In advanced cases, trabeculations may be absent or exhibit a cyst-like appearance, and, when such areas of radiolucence are more circumscribed, actual giant-cell tumor formation may be present. The lamina dura may be partially or completely absent, depending on the severity of the skeletal involvement, and the teeth, in which there is no alteration in radiographic density, stand out in marked contrast to the radiolucent osteoporotic bone.

With the disappearance of the lamina dura, the roots of the teeth appear to be spindle-shaped and present a picture similar to the appearance of the root of an extracted tooth. The cementum which covers the root is not as radiopaque as dentin, and when the lamina dura, which represents the tooth socket, disappears and there is decreased radiographic density of the surrounding bone, the cementum becomes less distinct. In successfully treated patients, the lamina dura is restored, and the image of the root again returns to its normal roentgenographic appearance and contour. Hence, the spindle-shaped appearance of the roots observed in hyperparathyroidism can usually be explained on the basis of an optical illusion.

A characteristic feature which has not been emphasized, yet is of significance, is the disappearance of the narrow radiopaque lines which represent the borders of the maxillary sinuses, nasal fossae, and the alveolar crest of the maxilla, and the

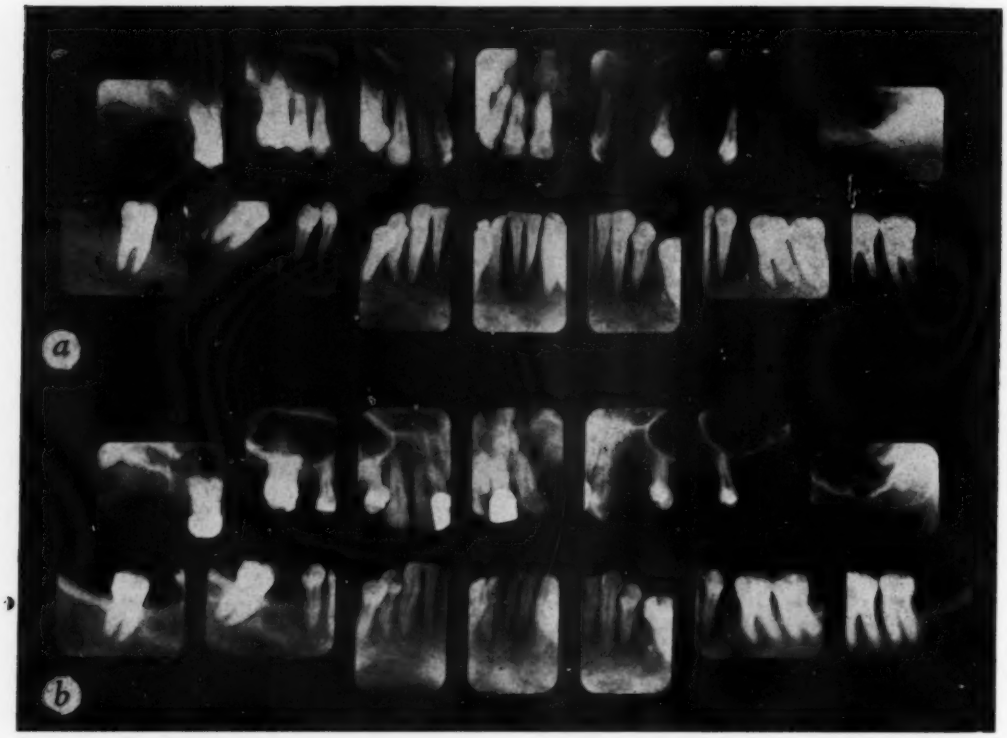

Fig. 8. Hyperparathyroidism. *a*. Roentgenogram made prior to treatment, showing marked osteoporosis, absence of lamina dura, spindle-shaped roots, absence of the thin radiopaque lines outlining the maxillary sinuses, and of cortex on the alveolar crest of the mandible. *b*. Roentgenogram made three years after successful treatment, showing reappearance of bone of normal radiographic density, normal lamina dura, normal appearing dental roots, radiopaque lines defining the borders of the maxillary sinuses, and cortex on the alveolar crest of the mandible.

wider radiopaque line which normally represents the cortical bone on the alveolar crest and inferior border of the mandible.

Roentgenograms made for a woman thirty-two years of age who was suffering from a primary hyperparathyroidism are shown in Figure 8. The roentgenogram in Figure 8*a* was made prior to the removal of an adenoma of the parathyroid gland, and that in Figure 8*b* three years after removal. The pre-treatment film shows osteoporosis of both jaws, with almost complete destruction of trabeculations in the left maxillary incisor region, absence of lamina dura, and obliteration of the radiopaque lines which define the limits of the maxillary sinuses, the nasal fossae, and also the cortex of the alveolar crest and inferior border of the mandible.

The roentgenogram made following treatment reveals bone of normal radiographic density. The lamina dura has reappeared, as have the radiopaque lines which mark the limits of the maxillary sinuses, nasal fossae, and the crest of the mandibular alveolar ridge. The radiopaque line which outlines the limits of the maxillary sinuses is slightly wider and more irregular than the uniform well defined line which appears in the normal maxilla.

In cases of more severe skeletal involvement there is a definite predilection to giant-cell tumor formation in the jaws, particularly the mandible. All giant-cell tumors of the jaws are by no means associated with hyperparathyroidism; however, their occurrence should suggest the possibility of the disease. Unsuccessful surgical treatment of these tumors has been given, on the premise that they were

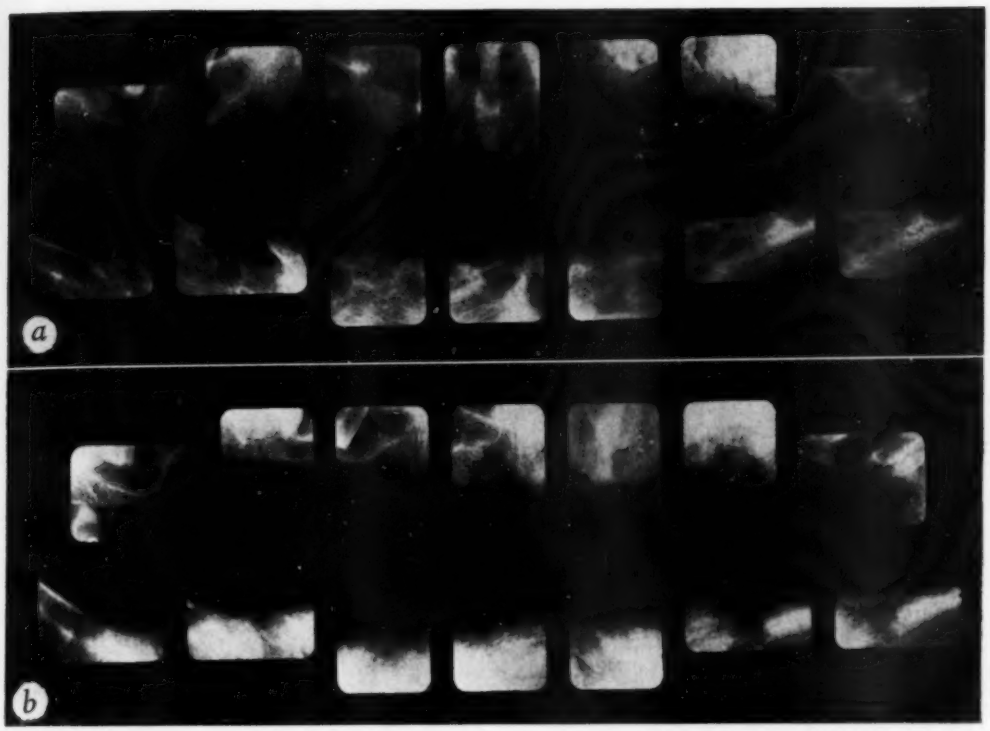

Fig. 9. Hyperparathyroidism. *a*. Roentgenogram made prior to removal of a parathyroid adenoma, showing cystic spaces in the mandible which were occupied by giant-cell tumors. *b*. Roentgenogram made five and a half months after successful treatment. The cystic cavities formerly occupied by the tumors have been replaced by abnormally dense bone of increased radiographic density.

local lesions. Such a case is illustrated in Figure 9. The roentgenogram reveals cystic spaces in both molar regions of the mandible, which were occupied by giant-cell tumors that had been unsuccessfully treated (Fig. 9*a*). While the picture of hyperparathyroidism is not as manifest in the edentulous jaw as it is when the teeth are present, there is an alteration of trabecular pattern of the bone adjacent to the lesions which is suggestive of generalized skeletal disease. Figure 9*b* is a roentgenogram made five and one-half months after removal of an adenoma of the parathyroid glands. The cavities formerly occupied by the tumors have been replaced by a dense sclerotic bone, and this has taken place without local surgical intervention. Regions in which the trabeculae have been destroyed, completely or extensively, may be replaced by sclerotic bone which is denser and more radiopaque than normal bone, and this picture is one which often permits a roentgenographic diagnosis of successfully treated hyperparathyroidism.

POLYOSTOTIC FIBROUS DYSPLASIA: ALBRIGHT'S SYNDROME (14)

The skeletal manifestations of polyostotic fibrous dysplasia, the cause of which is obscure, are lesions showing osteitis fibrosa, with a spotty distribution and a tendency to be unilateral. The roentgenographic appearance is unlike that of hyperparathyroidism in that there is no generalized osteoporosis, and there is sometimes increased radiographic density in addition to the areas of decreased radiographic density. In instances in which the jaws are involved, the lamina dura is absent in the regions of the lesions only.

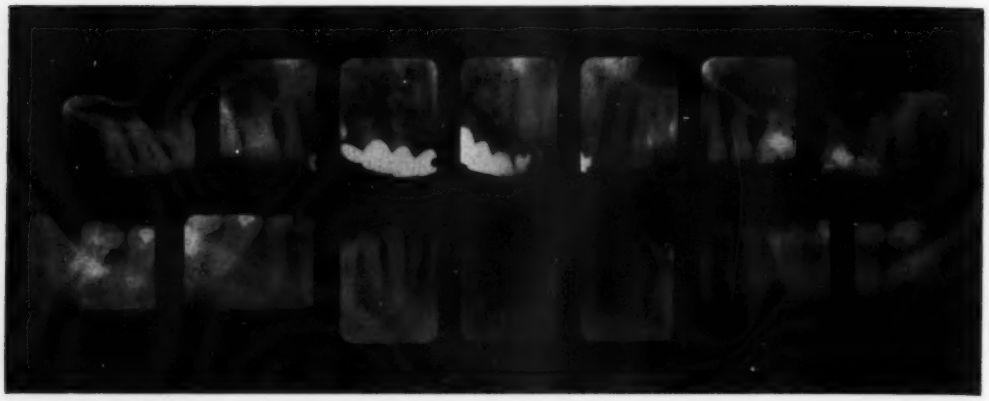

Fig. 10. Polyostotic fibrous dysplasia (Albright's syndrome). Dental roentgenogram showing lesions in the left maxilla and in the left molar and incisor regions of the mandible, as evidenced by alteration of trabecular pattern and slight decrease in radiographic density. Bone in uninvolved regions is normal in appearance.

A dental roentgenogram illustrating lesions of the jaws in fibrous dysplasia is shown in Figure 10. The patient was a man of forty-seven who had similar lesions in the left half of the skull and pigmentation of the skin on the left side. In the jaws the most extensive lesion involved the left maxilla and ended abruptly at the midline suture of the palate. In the mandible two lesions were present, one in the left molar region and the other in the premolar region on the left but extending across the midline to the canine region on the right. Since the greater part of the lesion was situated on the left, one might assume that it had its origin on that side. While there is some decrease in radiographic density, the presence of these lesions is evidenced chiefly by a marked change in trabecular pattern. The roentgenographic appearance of the bone adjacent to the involved regions is normal.

ADRENAL GLANDS

Androgenital Syndrome: In the event that an overproduction of adrenal androgenic hormones is present at birth, or develops early in childhood, dental development will be accelerated to a varied degree, but rarely to the same degree to which skeletal age is accelerated. Schour and Massler (15) studied an instance of hermaphroditism in a child aged four years and eight months and found that, while the carpal age was ten years and the craniofacial age ten to eleven years, the dentition was that of a child of six. Rushton (16) reported a case in which a girl six years and eleven months of age had a skeletal age of fourteen years and a dental age of ten years. He also reported a case of macrogenitosomia in a boy eight years and nine months of age, whose skeletal age was sixteen years and whose dental age corresponded to that of a child ten to eleven years old.

In primary hypogonadism in which there are delayed maturation and an overgrowth of bones, and in the hypergonadism in which there is early and accelerated maturation of the skeleton, there also may be an early and accelerated development and eruption of the teeth.

Cushing's Syndrome. According to Levine and Weisberg (17), Cushing's syndrome is associated with osteoporosis in 64 per cent of females and 75 per cent of males. The most common sites of occurrence are the vertebrae, ribs, and pelvis. The opinion has been expressed by Albright and Reifenstein (14) that the osteoporosis associated with Cushing's syndrome is caused by inadequate apposition rather than increased resorption of bone. The relative incidence of occurrence in the jaws is not known, for it has not been

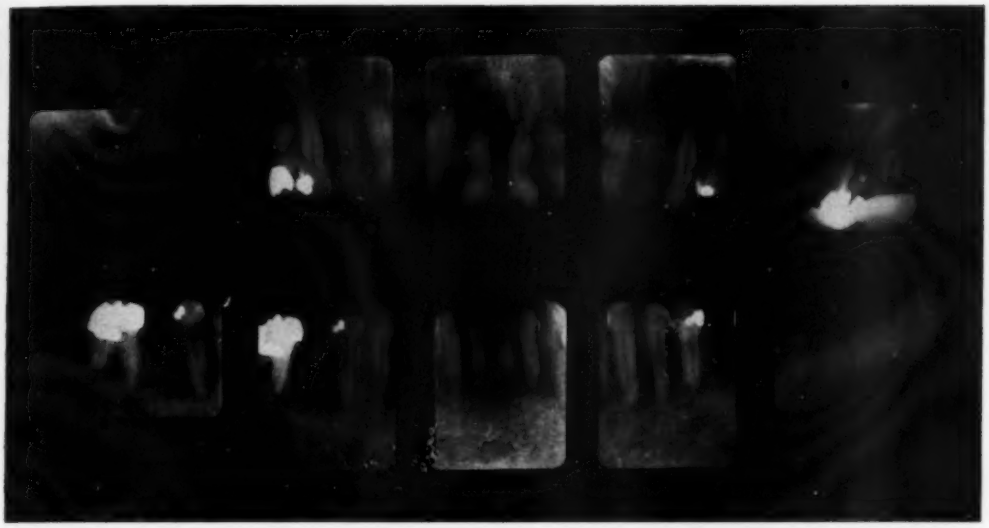

Fig. 11. Cushing's syndrome. Dental roentgenograms showing uniform osteoporosis of both jaws. There is not the marked transformation of trabecular pattern seen in hyperparathyroidism. However, the lamina dura is only faintly discernible.

adequately studied. Roentgenograms of the head and skull rarely produce satisfactory views of the maxilla and mandible for the detection of osteoporotic changes. The author has noted osteoporosis as revealed by the dental roentgenogram in two cases, one of which is illustrated in Figure 11. This is the roentgenogram of a woman forty-seven years of age who also had osteoporosis with multiple compression fractures of the lumbar and dorsal vertebral bodies. It revealed a uniform osteoporosis of the maxilla and the mandible, with partial obliteration of cortices, the lamina dura, and the radiopaque lines which define the borders of the maxillary sinuses. It did not present the marked transformation of trabecular pattern which is seen in osteoporosis associated with hyperparathyroidism.

PANCREAS

Hypo-insulinism (*Diabetes Mellitus*): That endocrine disturbances may be an etiologic factor in the occurrence of periodontosis has been shown by Becks (18). One of the disorders in which there is evidence of such a relationship is diabetes, in which periodontosis has long been considered by many as a pathognomonic symptom. Because of the high incidence of periodontosis in adults regardless of the systemic background, it is in most cases difficult to establish a relationship between the two conditions. That this does exist is supported by the frequent failure to obtain favorable results in periodontosis in the presence of uncontrolled diabetes.

Periodontosis occurs rarely in children and, while it is by no means a constant feature in juvenile diabetes, yet on occasion one sees in uncontrolled cases such rapid and marked destruction of alveolar bone that it would be difficult to explain its presence solely on the basis of coincidence. Such lesions may be limited to one or a few regions, or they may be generalized and involve all the teeth. The dental roentgenogram in such a case is shown in Figure 12. It is that of a boy eighteen years of age who had been suffering from diabetes for a period of twelve years. During much of that time the diabetic condition had not been kept under control. The roentgenogram reveals destruction of alveolar bone throughout both jaws, involving all the teeth, and so extensive that the roots of many of them are completely

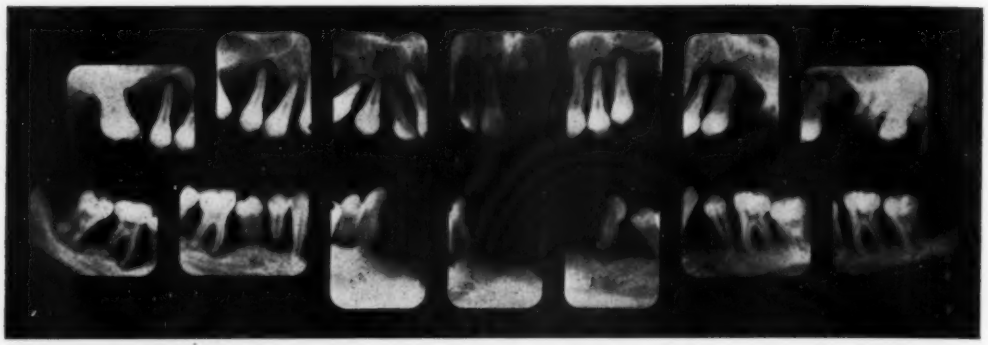

Fig. 12. Diabetes (juvenile), in boy eighteen years of age. Dental roentgenogram reveals almost total destruction of alveolar bone as a result of periodontosis. Many of the teeth are supported by soft tissue only, and several of them have been sloughed. (Reproduced, with permission, from Stafne, E. C.: Dental Roentgenologic Aspects of Systemic Disease. J. Am. Dent. A. **40:** 265–283, March 1950.)

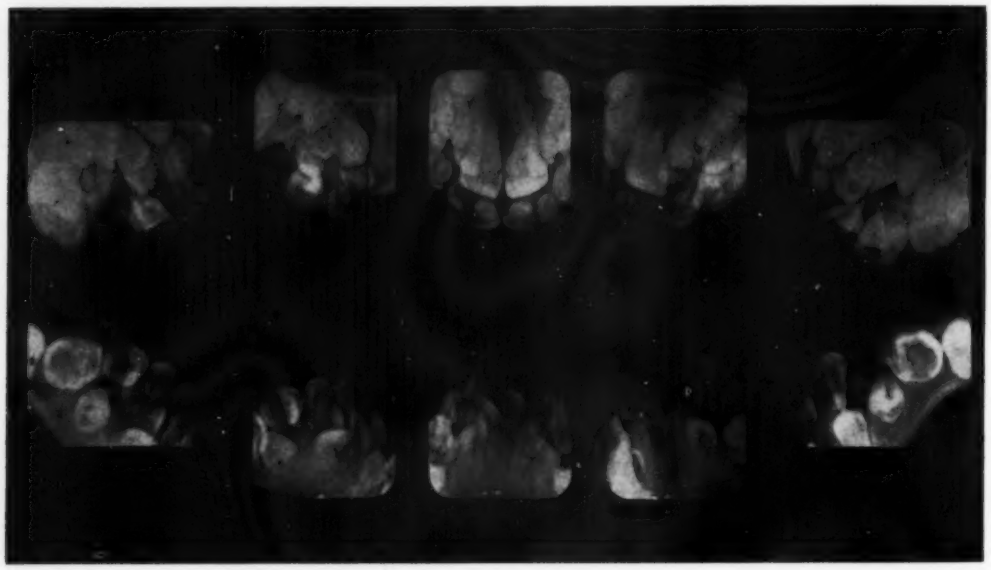

Fig. 13. Progeria (Hutchinson-Gilford syndrome) in girl ten years of age. Roentgenogram shows prolonged retention of primary teeth and non-eruption of permanent teeth. The eruption age is approximately four years behind the chronologic age. (Reproduced, with permission, from Lovestedt, S. A.: Examples of Dental Dysplasia. Am. J. Orthodontics. **33:** 625–629, August 1947.)

devoid of osseous support. Several teeth have been lost as a result of the destruction and others are in the process of being sloughed.

PROGERIA
(HUTCHINSON-GILFORD SYNDROME)

Progeria is a form of dwarfism in which the patient passes directly from childhood to old age. It usually becomes manifest in a previously healthy patient at approximately one year of age and is characterized by precocious development of arteriosclerosis and loss of subcutaneous fat and hair. The cause is obscure. Talbot and co-workers (19) studied an instance and were of the opinion that the condition is a metabolic disturbance in which, even with adequate amounts of food, all calories appear to be used for energy metabolism with nothing left for growth and subcutaneous fat.

The dental roentgenogram of a girl ten years of age who had progeria is shown in Figure 13. This case was reported by Mitchell and Goltman (20) in 1940, except for the dental findings, which were reported by Lovestedt (21) in 1947. The roentgenogram reveals prolonged retention of the primary teeth with little evidence of resorption of the roots. Whether the lack of normal quality or character of bone is responsible for the failure to produce resorption of the roots is problematic. The unerupted permanent teeth are of normal size, and are overcrowded and malposed in very small underdeveloped jaws. It is doubtful that most of them will erupt. Dental development is retarded slightly, and the eruption age is approximately four years behind the chronologic age. The dental picture is not one of precocity, but of retardation, in direct contrast to that seen in hyperthyroidism.

COMMENT

While the dental roentgenogram has on many occasions been instrumental in revealing a clue which has led to a diagnosis of endocrine and other disturbances, it has rarely been employed to determine the success or progress of treatment. Its use for that purpose has been helpful in evaluating progress in the treatment of disturbances of the thyroid and parathyroid glands and should also prove to be of aid in estimating the success of treatment of some other endocrine disturbances. In hypothyroidism in which retarded dental development is a feature, Engel and coworkers (22) have found that craniofacial and dental patterns of untreated children lag behind those of children receiving thyroid therapy. In hyperparathyroidism the maxilla and mandible are among the most common sites of osteoporosis and tumor formation, and in the event that skeletal features of the disease are present, the dental roentgenogram has been of particular value in detecting minimal changes. An opportunity to observe dental roentgenograms following treatment has revealed early evidence of a return to normal, including the rapid healing of regions which had been destroyed by giant-cell tumor formation.

In abnormal skeletal development caused by hormonal disturbances, the degree of dental development and the degree of development of carpal bones are not always consistent. More often dental development is retarded or accelerated to a lesser degree than carpal development, particularly in those disorders which are amenable to and have undergone treatment. In some instances, however, the variation between dental and chronologic age has been as great as that between carpal and chronologic age.

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SUMARIO

Aspectos Odonto-Roentgenológicos de las Afecciones Orgánicas. I. Disendocrinias

Todo influjo que la disfunción endocrina pueda ejercer sobre los dientes se halla casi absolutamente limitado al período de desarrollo de los mismos, traduciéndose por retardo o aceleración del desarrollo y de la salida o por defectos e imperfecciones estructurales. Los efectos sobre los huesos de las mandíbulas son en gran parte semejantes a los producidos en otros huesos. En los casos en los que ocurre desarrollo excesivo del esqueleto, la mandíbula, debido a la persistencia normal del cartílago de crecimiento del cóndilo, es susceptible de experimentar mayor hipertrofia que la mayoría de los otros huesos.

Cuando se altera la estructura o calidad del hueso, la radiografía intraoral posee valor diagnóstico, pues a menudo revela hasta una deformación mínima del patrón trabecular y leve desmineralización en casos en que no son observables esas manifestaciones en otras partes. Una de las alteraciones que pueden ocurrir en caso de desmineralización es la obliteración o desaparición de la lámina dura, o sea la uniforme línea radioopaca que representa el alvéolo.

El estudio de la radiografía dental también ha resultado útil para estimar la respuesta al tratamiento en los trastornos del tiroides y de los paratiroides, y debe ser igualmente de valor para determinar el éxito de la terapéutica en otras disendocrinias.

En las anomalías del desarrollo esquelético ocasionadas por trastornos hormónicos, no siempre coinciden la magnitud del desarrollo dental y la de los huesos carpianos. Lo más frecuente es que el desarrollo dentario se retarde o acelere menos que el carpiano, en particular en perturbaciones en vías de tratamiento o susceptibles a éste.

Los distintos trastornos endocrinos son discutidos por separado, con radiografías apropiadas.

Betatron Cancer Therapy[1]

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IN THE LAST FEW years we have all witnessed with varying degrees of interest a tremendous increase in the upper limits of supravoltage energies for possible therapeutic application. A variety of radiations have become available, some in adequate quantity for the first time. We have been using a 24,000,000-volt betatron which yields a very powerful beam of x-rays and a less well developed external beam of electrons (3, 6). Most of our work in the last year and a half has been with the x-ray beam, although at present we are diverting some of our attention to engineering problems and animal tissue effects of the electron beam.

The betatron x-ray beam offers some very appealing distribution advantages in tissue (4). In Figure 1 is shown the distribution of density in a film phantom with a 200-kv. beam path and with the 24,000,000-volt betatron x-ray beam path. In the latter the sparing effect on the superficial tissues at the site of entrance of the beam (on the left in the illustration), the concentration of density deeper along the path, the extreme degree of useful penetration, and the lack of significant scatter along the edges of the path are important. In contrast, the 200-kv. beam path shows no sparing effect at the site of entrance of the beam but rather a concentration of density at the surface and for a few centimeters forward, limited penetration, and considerable side scatter. This distribution of density should clearly indicate separate zones of usefulness for the different types of equipment, although the decreased skin reactions with the betatron may eventually increase its applicability even for subsurface lesions.

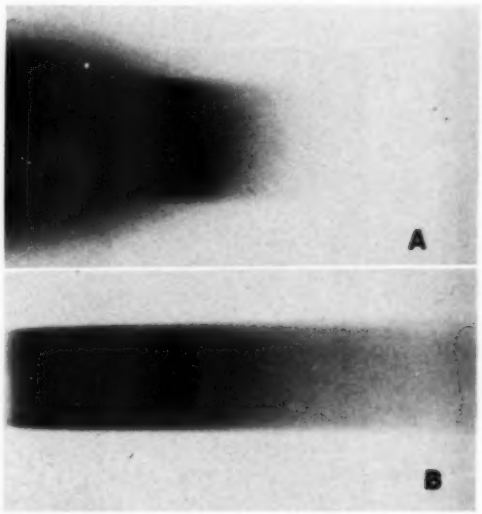

Fig. 1. Film density paths for 200-kv. beam (A) and for 24-mev betatron beam (B).

With conventional x-ray therapy equipment, dosage is conveniently measured and understood in terms of the roentgen. We have also been using the roentgen unit for dosage measurement with the betatron but are fully aware of the need for a method of measuring dissipated energy in terms of ergs per gram of tissue. For this purpose, we are investigating sensitive calorimetric methods of making a fundamental measurement of the actual energy dissipated by the x-ray beam. We use a 25-r Victoreen thimble chamber inserted in an 8-cm. cube of lucite. In the middle of this cube, the chamber is at the maximum or peak of the depth dose intensity. Our dose rate under these conditions, and with complete collimation and filtration of the beam, is usually around 100 r per minute at 84 cm. from the target of the tube. The dose rate is about doubled without filtration. Biological investigations on relative effectiveness of the

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betatron roentgen by Quastler (5) and more recently by us (1, 2, 4) have shown that greater quantities of measured roentgens are required from the betatron than from machines of lower voltage to produce equal tissue effects. Unfortunately this difference is not a constant but varies with the degree of effect one wishes to observe in tissues. Minimal effects of comparable degree are produced in a 3:4 ratio of dosage, while maximum tolerance effects are more nearly 1:2 in ratio. Thus, in cancer therapy, our total doses in terms of the betatron r will appear to be almost twice what one is accustomed to at lower voltages.

Our experiences in subjecting 33 different patients to betatron therapy are by no means adequate for predictions as to the most favorable types of cancer for this therapy. We have tried to select types known to be generally radiosensitive, and smaller than our maximum field size of 15 cm. These are too frequently limitations in a charity institution, such as ours, where most of the patients have already had maximum tolerance amounts of other forms of therapy, or have widespread terminal cancer.

Preparation of a patient selected for treatment is more complicated than for conventional procedures, though we are sure that extension of some of these preparatory measures to conventional voltage therapy would bring about better results. We refer particularly to the precise determination of tumor location and extent, the plotting of beam paths which will most effectively reach the tumor, and delivery of an adequate dose to all its layers.

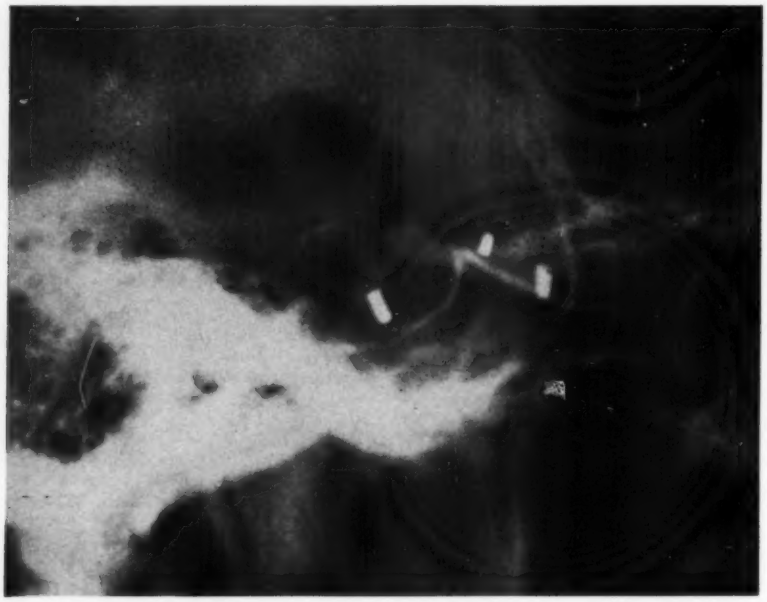

Fig. 2. Lead markers on opposite sides of skull superimposed for proper beam direction to pituitary. Other markers improperly located.

The tumor is best localized by the surgeon at the time of excision or biopsy. We prefer that he actually mark the extent on surface areas of the body rather than leaving it to us to locate points on the basis of his written description. We also rely heavily on x-ray localizations including surface markings (Fig. 2), stereoscopic, right-angle, laminagraphic, fluoroscopic, and contrast media examinations. The information obtained is transferred to drawings of body cross sections and cor-

related with casts of the section of the body to be treated (Fig. 3).

The selection of beam size and plotting of fields are interesting and important. Our intention is to obtain:

1. Highest and most uniform dose in the tumor.
2. Lowest absorption in surrounding radiosensitive tissues and organs.
3. Lowest total skin dose, with particular attention to the exit area.
4. Lowest volume dose in the body consistent with maximum dose in the tumor.
5. A total dose of at least 10,000 r in four to four and a half weeks to carcinomas and 7,500 r in three to three and a half weeks to brain and pituitary tumors.
6. Multiple fields (usually 5 to 9), in order to avoid dose cumulation in the same normal tissues.
7. Separate entrance and exit beam sites.

Preliminary dose calculations are made individually for every case and every field separately. These include dose in:

1. Entrance skin.
2. Near surface of the tumor.
3. Middle of the tumor.
4. Distant surface of the tumor.
5. Exit skin.

and the integral dose in:

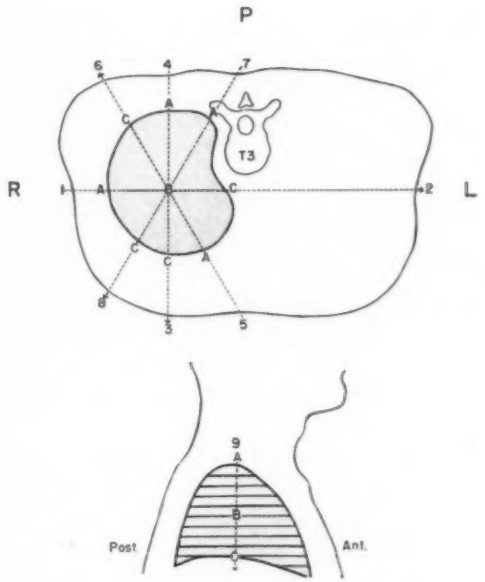

Fig. 3. Treatment planning for upper lung neoplasm. Points A, B, and C should receive about the same amounts of treatment.

6. Normal body.
7. Tumor.

The accompanying tables summarize our clinical data in the briefest sort of way. We would call attention particularly to the gradual increase in daily and total doses as our confidence and knowledge increased, the reasonable length of time for the series of treatments, and the fact that the present status of the patient, *i.e.*, alive

TABLE I: GROUP 1, TREATED AUGUST—OCTOBER 1949

Patient	Age	Location	Type	Total Tumor Dose (r)	Fields	Treatments	Overall Time (days)	Comment
1. F. H.	72	Hypopharynx Larynx, and nodes	Epidermoid	553 5,680 r (200 kv.)	2 3	4 28	49	Living. Locally healed. Radon to nodes
2. B. D.	69	Alveolar ridge	Epidermoid	7,565	2	37	52	Marked regression. Residual neoplasm. Death from heart attack four months later
3. J. P.	44	Larynx, 2 cords	Epidermoid	6,239	5	32	46	Living. Regression. Edema or recurrence now. Refused surgery
4. W. Z.	30	Cerebellum	Sarcoma	866	5	6	9	Living. Originally treated in 1945 at 400 kv. This course for recurrent focal symptoms

TABLE II: GROUP 2, TREATED DECEMBER–JANUARY 1950

Patient	Age	Location	Type	Total Tumor Dose (r)	Fields	Treatments	Overall Time (Days)	Comment
1. A. R.	62	Pituitary	Chromophobe	5,989	9	19	27	"Satisfactory"
2. G. T.	77	Bladder	Transitional	6,450	8	28	39	Bleeding subsided. Died seven months later. No autopsy
3. C. J.	55	Palate	Adenocarcinoma	8,971	9	26	39	Living. Residual tumor site resected recently
4. F. B.	53	Cervix	Epidermoid	5,285+				Living. Cervix healed.
				6,008	8	28	39	Parametrial induration
				(2 series)	8	17	25	
6. U. V.	63	Lung	Squamous	6,520	9	25	35	Progressive pleural effusion. Died two months later

TABLE III: GROUP 3, TREATED FEBRUARY–MARCH 1950

Patient	Age	Location	Type	Total Tumor Dose (r)	Fields	Treatments	Overall Time (Days)	Comment
1. C. G.	65	Bladder	Transitional	2,560	7	7	9	Treatment interrupted by cardiac infarct. Died one week later. No gross tumor at autopsy. Slides showed marked disorganization of cancer cells (Fig. 5)
2. S. L.	61	Pituitary	Chromophobe	5,715	9	15	18	"Satisfactory"
3. M. D.	58	Epiglottis	Epidermoid	400	1	1	1	Severe morphine addict out of control
4. D. F.	41	Tongue	Epidermoid	9,040	6	24	32	Marked slough, tongue soft, healing. Died three and a half months later of pleural metastasis
5. I. L.	71	Larynx	Epidermoid	9,025	7	23	32	Hoarseness decreased. Edema or recurrence. Died
6. B. M.	63	Lung	Pancoast	9,081	6	23	32	Living. Pain ceased. Rib regenerated. Gaining weight. Working
7. T. W.	65	Lung	Bronchogenic	8,960	6	24	35	Living. Density decreased slowly. Now increasing
8. P. M.	36	Brain (frontoparietal)	Oligodendroglioblastoma	5,746	9	15	21	Living. Regained equal muscular strength. Doing housework. A few fits persist. Apathy ceased. Speech improved
9. F. C.	46	Brain (frontoparietal)	Astrocytoma	5,705	8	15	19	Living. Memory and personality improved. Tension decreased

or dead, can by no means be used as a true measure of the value of the betatron. These are desperate cases, and we have learned a great deal, even from the patients who died, that will serve us usefully when we see patients early enough to have a chance of saving them.

The most significant observation in the cases listed in Table I was the massive necrosis of tumor that occurs when about a third of the total dose has been given. The second case illustrates this point. As in our other patients with oral and pharyngeal tumors, great masses of diseased tissue fell out while the remaining intact normal tissue showed remarkable ability to regenerate and heal the defects. This is appreciated even more if one recalls the difficulty of getting a tumor necrosis of such extent to heal following radium insertion.

Table II needs little comment other than an explanation of terminology at the end

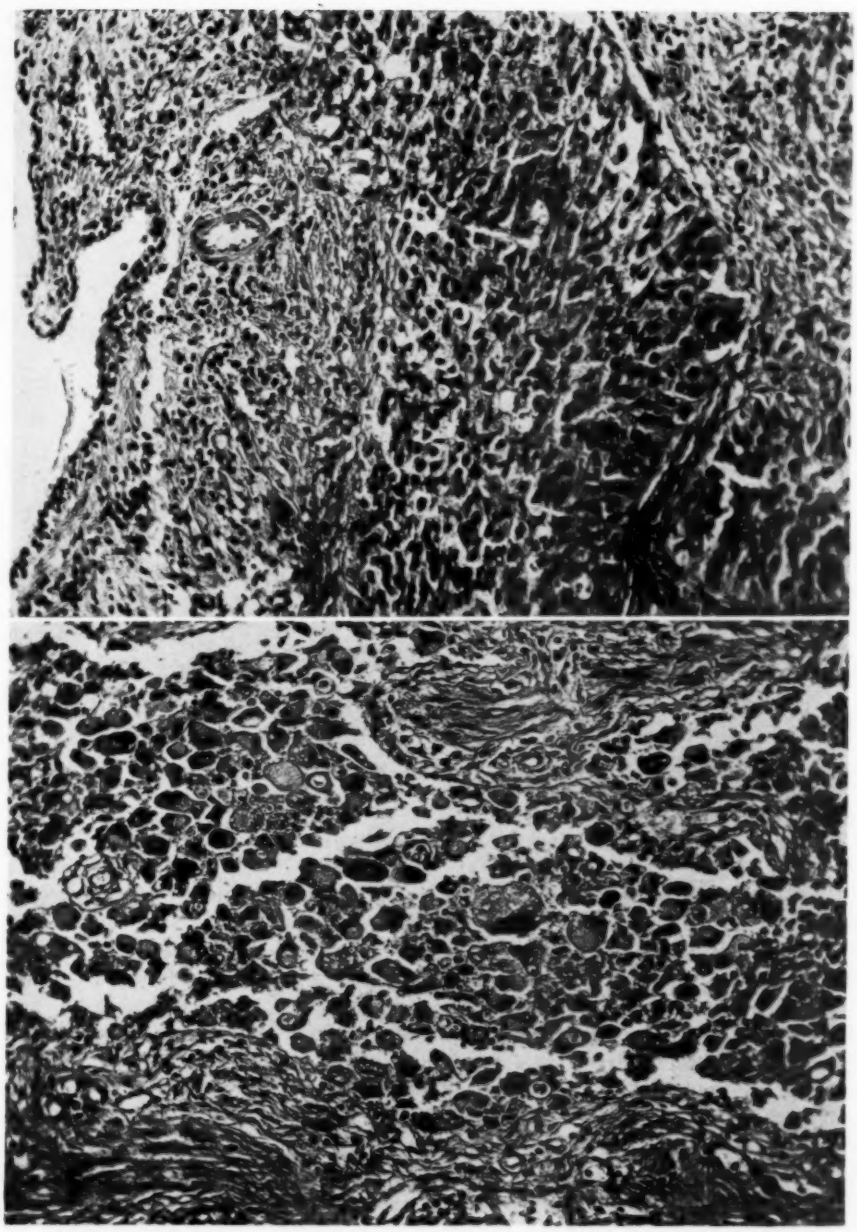

Fig. 4. Case 1, Table III: Biopsy material from bladder neoplasm.
Fig. 5. Case 1, Table III: Autopsy specimen from bladder wall one week after administration of 2,560 betatron r to tumor.

of the first case. Effects of treatment of pituitary tumors are truly long-range problems of observation, so that "satisfactory" has been used where no complications have arisen after treatment and the patient appears to be doing well.

Microscopic sections taken from the first patient listed in Table III are valuable,

even though we were unable to complete treatment. An initial biopsy section from the bladder is reproduced in Figure 4, showing a highly anaplastic tumor. Death ensued one week after a massive posterior cardiac infarction incident to bronchopneumonia; treatment with the betatron was not given during this period. No gross tumor could be found in the bladder at autopsy, but serial sections of the bladder wall showed marked tumor damage (Fig. 5), while a known metastatic lesion in the lumbar spine, well outside the treated zone, showed no change from the detail observed in the original bladder tumor biopsy (Fig. 6).

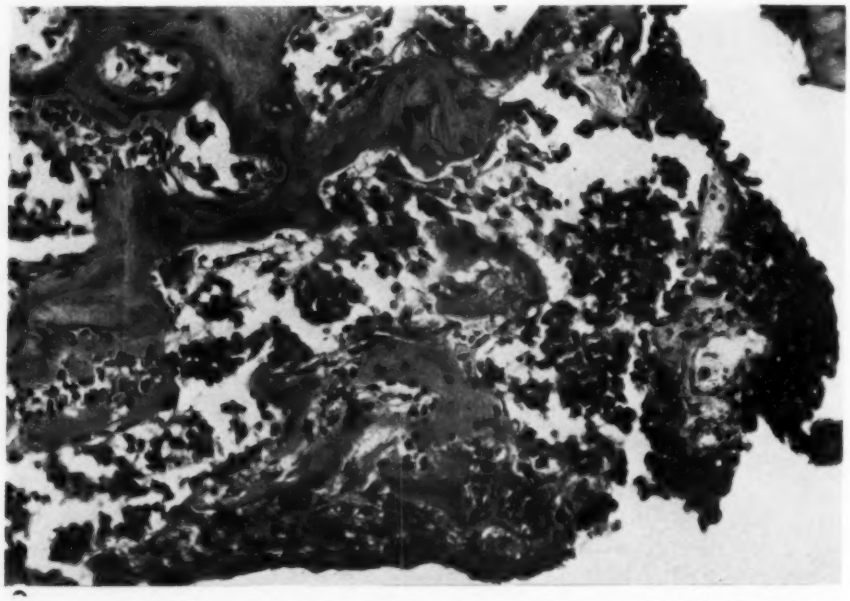

Fig. 6. Case 1, Table III: Autopsy specimen from untreated metastasis in lumbar spine.

The sixth patient listed in Table III has shown particularly encouraging progress. The pain with this Pancoast tumor (Fig. 7) began to decrease near the end of treatment and had entirely disappeared six weeks after its completion. The parenchymal density is slowly regressing, and the previously destroyed first rib has recalcified, as shown in Figure 8. Recalcification was first detected four months after treatment, and the present stage was reached at eight months. A more recently treated Pancoast tumor is following a similar course, except that the pain lessened markedly during treatment and is now gone, while the patient is already gaining weight.

The eighth patient in this same group had a large oligodendroglioblastoma. She was aphasic and hemiplegic. A decompression and biopsy were performed. The tension of the decompression decreased rapidly with treatment; there has been restoration of equal muscular strengths, and the patient is working. The regrowth of hair following almost total epilation from the betatron x-ray beam is striking (Fig. 9). Its present curl and sheen are in contrast to its former straight and rather dull quality.

The sixth patient in Table IV is noteworthy in that he experienced no irradiation sickness in spite of treatment through 15-cm. fields and dosage of over 600 r a day, to the upper abdomen. Repeated x-ray examinations of his intestinal tract have failed to show evidence of mucosal edema or atrophy.

TABLE IV: GROUP 4, TREATED MAY–JUNE 1950

Patient	Age	Location	Type	Total Tumor Dose (r)	Fields	Treatments	Overall Time (Days)	Comments
1. V. L.	31	Pituitary	Eosinophile	6,623	8	15	25	Living. All complaints less
2. I. Z.	62	Larynx	Epidermoid	9,990	5	22	32	Living. Voice better. Cords now mobile. No visible tumor. Nodes less
3. T. N.	48	Tongue	Epidermoid	10,016	8	22	32	Tongue softened. Died five weeks later after abdominal operation
4. S. Z.	58	Lung	Oat-cell	4,682	5	11	16	Patient interrupted treatment. Refused to return
5. R. V.	46	Lobotomy	Brain	2,874	3	3	4	Terminal test. Died four weeks later. Epilation on exit ports only. Brain being examined now
6. W. M.	49	Pancreas (head)	Adenocarcinoma inoperable	9,486	8	21	28	Living. Icterus disappeared; strength returned. Working. Slight diarrhea at times

TABLE V: GROUP 5, TREATED OCTOBER 1950

Patient	Age	Location	Type	Total Tumor Dose (r)	Fields	Treatments	Overall Time (Days)	Comments
1. H. B.	57	Lung	Pancoast	11,063	8	20	28	Living. Swelling and pain disappeared. Tumor shrinking. Working, gaining weight
2. A. D.	60	Lung	Lymphosarcoma	10,010	7	21	32	Living. No visible or palpable residual. Abdominal metastasis
		Nodes		2,600	1	3		
		Nodes		4,350	1	6		
3. J. P.	69	Lung	Bronchogenic	10,240	7	21	32	Living. Weakness and dysphagia
4. A. B.	64	Brain (temporo-parietal)	Astrocytoma	7,990	8	16	21	Living. No increase in pressure. "Satisfactory"
5. J. T.	57	Lung	Oat-cell	9,505	6	25	35	Living. Lungs, neck nodes, and mediastinum clear. Liver metastases now
6. W. S.	65	Tongue	Epidermoid	10,037	6	18	24	Living. Tumor regressing rapidly
7. T. P.	21	Brain	Glioblastoma	795	2	2	2	Treatment discontinued; extreme agitation
8. E. W.	56	Brain	Glioblastoma	7,560	9	15	21	Living. Prolapse increasing
9. L. G.	64	Lung	Bronchogenic	1,315	5	5	7	Failed rapidly. Died outside hospital

The fifth patient in Table V has shown a remarkable change with treatment. The pre-treatment chest film is shown in Figure 10. A film taken at the end of treatment (Fig. 11) shows no residual evidence of disease. Recently, however, the liver has become enlarged and a definite metastatic retroperitoneal mass has developed.

DISCUSSION

We have been particularly interested in the possible complications secondary to exposure of rather large volumes of normal tissues which is unavoidable with as penetrating a beam of x-rays as that obtained with the 24-mev betatron. So far we have not observed significant blood changes in these patients, there has been a minimal amount of radiation sickness, and the skin reactions, while greater on the exit than on the entrance surfaces, have been remarkably mild and relatively asymptomatic. The latter is accounted for in part by the distribution of energy in the tissues and by

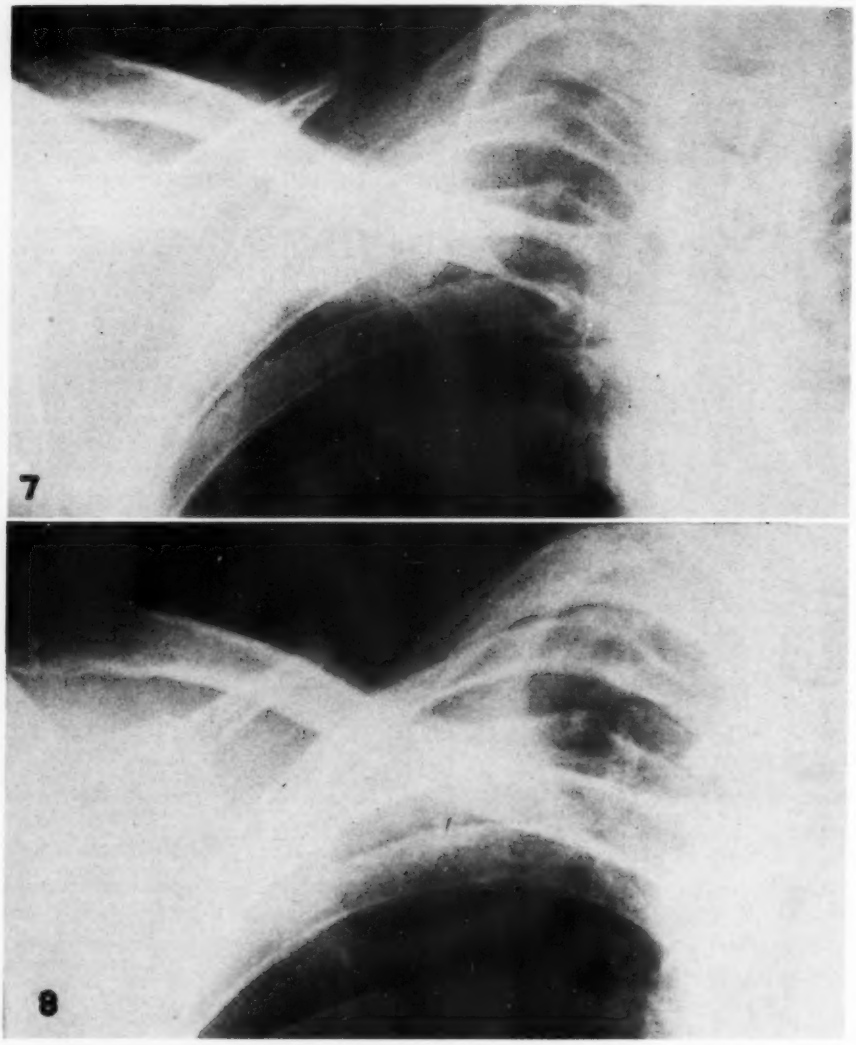

Fig. 7. Case 6, Table III: Pancoast tumor with parenchymal mass and rib destruction before treatment.

Fig. 8. Case 6, Table III: Eight months after treatment. Note regeneration of rib and reduction in soft-tissue mass.

the fact that we can easily reach a tumor with more fields than with conventional voltage therapy units. We attempt to plot out five to nine fields of attack for each lesion, but extremely sensitive normal tissues in some of the paths, or unusually large volume doses to the same normal tissues, sometimes alter this number.

The end-point for a treatment series is determined on the basis of our present interpretation of relative effectiveness of the beam and the obtaining of a uniform dose in the tumor. Our skin doses are calculated at 2.5 mm. below the surface. This is the approximate average depth level of the capillary bed and hair follicles, which contribute most obviously to observable effects.

Table VI is representative of some of the analyses we have been performing with our

data. These details relate to seven patients in Table V. There is considerable difference in highest and lowest skin doses depending on number of ports used, superimposition of entrance and exit ports at times, and the inherent difference in levels between entrance and exit skin doses. The variations in distribution of dose within the tumor are remarkably slight, as shown in the columns headed "Tumor Dose." The average dose in irradiated healthy tissue is surprisingly low with these methods. With a larger group of patients, it should average approximately 10 per cent of the tumor dose.

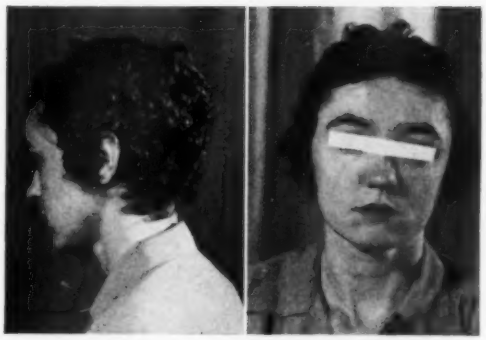

Fig. 9. Case 8, Table III: Regrowth of hair eight months following almost total epilation from 5,746 betatron r to tumor in frontoparietal area.

In addition, we have been calculating volume dosage measurements both for the tumor and for healthy tissue unavoidably irradiated during treatment. Table VII summarizes this work on the same seven patients (Table V). The integral volume dose is the integrated product of the total volume irradiated and the dose level to which it was exposed. It is expressed in terms of megagram-roentgens. The integral tumor dose is essentially the integrated product of the tumor volume expressed in grams and the dose level to which it was raised. The tumor volume is the zone in which we are trying to concentrate as high a dose as possible while holding down the

TABLE VI: SKIN DOSE, TUMOR DOSE, AND DOSE TO NORMAL TISSUES IN SEVEN PATIENTS OF GROUP 5 (TABLE V)

Patient	Skin Dose* (r)		Tumor Dose* (r)			Average Dose in Irradiated Healthy Tissue* (r)
	Highest	Lowest	Highest	Lowest	Center	
1. H. B.	2,020	620	11,073	10,420	11,073	856
	18.3%	5.6%	100%	94.4%	100%	7.7%
2. A. D.	1,595	584	10,100	9,780	9,914	1,513
	16.1%	5.9%	102%	98.7%	100%	15.3%
3. J. P.	1,990	707	10,450	9,120	10,240	1,567
	19.4%	6.9%	102%	89%	100%	15.3%
4. A. B.	1,545	396	8,170	7,970	8,090	1,028
	19.1%	4.9%	101%	98.5%	100%	12.7%
5. J. T.	2,360	1,338	9,870	9,370	9,555	2,836
	24.7%	14%	103.5%	98.2%	100%	29.7%
6. W. S.	1,940	593	10,035	9,620	10,035	662
	19.3%	5.9%	100%	95.8%	100%	6.6%
8. E. W.	1,170	764	7,840	7,720	7,720	683
	15.2%	9.9%	101.5%	100%	100%	8.9%

* % relative to center of tumor dose.

TABLE VII: INTEGRAL DOSE (MEGAGRAM ROENTGENS) IN SEVEN PATIENTS IN GROUP 5 (TABLES V AND VI)

Patient	Total Volume	Tumor Volume	Irradiated Healthy Tissue Volume	Average Dose in Irradiated Healthy Tissue (r)
1. H. B.	15.219	6.925	8.294	856
2. A. D.	21.500	4.973	16.527	1,513
3. J. P.	51.168	23.785	27.383	1,567
4. A. B.	12.240	4.470	7.770	1,028
5. J. T.	54.825	19.690	35.135	2,835
6. W. S.	10.336	5.075	5.261	662
8. E. W.	11.050	5.940	5.110	683

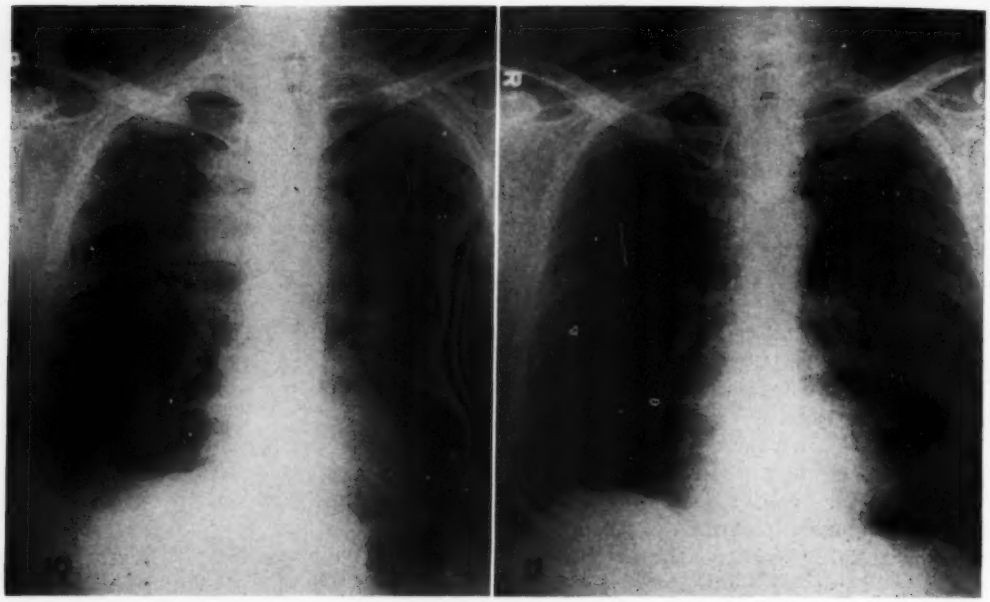

Fig. 10. Case 5, Table V: Oat-cell carcinoma of right upper lung and mediastinum, and right hydrothorax before treatment.

Fig. 11. Case 5, Table V: Patient on last day of treatment totaling 9,505 betatron r to the tumor.

dose in the surrounding volume. The figures in the next to the last column are the difference between the previous two columns and represent, therefore, the integral volume dose for the healthy tissue volume through which the beams passed to reach the lesion. The final column shows the average dose in the irradiated healthy tissue volume. As compared with the "center of tumor dose," it represents roughly 10 per cent. One criterion of a good treatment is a high tumor dose with a low average dose in the irradiated healthy tissue. In the fifth patient in this analysis, the latter was relatively high, which may possibly explain the occurrence of radiation sickness in this instance. By reason of the extent of the disease the total volume irradiated was the greatest in our experience with the betatron.

SUMMARY

1. Clinical trials of the 24-mev betatron have shown advantageous dosage distribution.

2. The measurement of dose quantity in terms of the roentgen is convenient but probably not ideal.

3. The extreme penetration and distribution of intensity of the x-ray beam from the betatron require special attention in treatment planning.

4. The patients treated thus far have shown encouraging responses, but the extent of their disease when treatment started precludes a very high ultimate salvage rate.

5. The betatron is not a substitute for early diagnosis and prompt treatment of cancer, and does not prevent the appearance of metastases from disease already disseminated outside the treated area.

6. Integral volume doses for healthy tissue unavoidably irradiated and integral volume doses for the tumor itself give a numerical expression of the dose delivered in a patient. These quantities can be compared from patient to patient and may help to explain symptoms and complications. The figures will be particularly interesting when compared with figures from treatments at other energy levels.

7. We are of the opinion that wider application of the betatron is justified.

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Addendum: Since this paper was submitted for publication, the calorimetric method has been developed and employed to calibrate the output of x-ray generators, including the betatron, in absolute flux units (ergs/cm²-second). Together with ionization distribution measurements in water, this flux calibration permits a calculation of the dose in energy units. Accordingly, all dose measurements in this paper expressed in betatron "roentgens" can be converted into ergs/gram by multiplying by the factor 100 ergs/gram-roentgen, and the integral doses reported in megagram-"roentgens" can be converted into joules (1 joule = 10^7 ergs) by the factor 10 joules/megagram-roentgen. The use of such absolute energy units is in agreement with the Recommendations of the International Commission on Radiological Units.

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SUMARIO

Betatronoterapia del Cáncer

Una serie de 33 enfermos con cáncer de varias formas fué tratada con el haz de rayos lanzado por un betatrón de 24,000,000 voltios (24 mev). Este método muestra varias ventajas sobre la terapéutica corriente en lo relativo a distribución de la dosis en los tejidos, o sean, menor efecto sobre los tejidos superficiales en el punto de entrada del haz, un grado extremado de penetración útil y falta de mayor dispersión a los lados. La dosis se mide convenientemente en términos de roentgens, pero hay que tener presente que, para producir efecto igual en los tejidos, se necesitan mayores cantidades de roentgens medidos que con los aparatos de bajo voltaje.

Debido a la suma penetración del haz y a la distribución de la intensidad, precisa mucho cuidado en la localización del tumor y determinación de su tamaño, en el trazado del trayecto del haz y en la entrega de una dosis adecuada a todos los niveles de la lesión. Los AA. han tratado de administrar una dosis total por lo menos de 10,000 r en cuatro a cuatro y media semanas a los carcinomas y de 7,500 r en tres a tres y media semanas a los tumores del cerebro y de la hipófisis, usando campos múltiples (5 a 9) para evitar la acumulación de rayos en los tejidos normales.

Los resultados han sido alentadores en los casos tratados, pero hay que recordar que la extensión de la enfermedad en los mismos excluye un índice elevado de éxitos. Hasta ahora no se han observado significativas alteraciones sanguíneas; hubo una mínima proporción de enfermedad irradiatoria; y las reacciones cutáneas, si bien mayores en las superficies de salida que en las de entrada, fueron notables por lo leves.

Preséntanse dosis íntegras por volumen para los tejidos sanos irradiados inevitablemente y para el tumor mismo, en casos seleccionados.

(*For Discussion, see following page*)

DISCUSSION

(Papers by Roswit and Kaplin,[1] McCort and Robbins,[2] and Harvey, Haas and Laughlin)

Danely P. Slaughter, M.D. (Chicago, Ill.): At first glance it may seem that these three papers are somewhat unrelated. I think, however, that the Program Committee was very shrewd in juxtaposing them. They illustrate very well the advances and changing trends in cancer therapy today. As a surgeon I will do the best I can in discussing them.

The presentation of Drs. Roswit and Kaplan on nitrogen mustard was excellent. I am in thorough agreement with their figures and perhaps will go even farther. Our results in the Tumor Clinic at the Research Hospital have been quite surprising, and my impression is that they are even better than mentioned in this paper.

Nitrogen mustards are effective on epithelial tumors if you can get the HN_2 to the tumor cell. As you probably all know, that is being done now by intra-arterial injection and some quite startling effects have been produced on tumors of the extremities and in the head and neck area. A polythene cannula has been placed in the external carotid artery and a series of injections have been given there. Even well differentiated squamous-cell cancer has shown remarkable regression—though still only temporary. I have asked our thoracic surgeons to apply this treatment in pulmonary cancer—at thoracotomy—when they find an inoperable lesion, if it is anatomically possible to inject the agent into the pulmonary artery or to the branch of the lobe involved and put a temporary tourniquet about the hilus of the lung to increase the exposure. This has not been done yet, but it is one approach we intend to use.

The study by Drs. McCort and Robbins of lymph node metastases in bronchogenic cancer is a very scholarly and thorough presentation. They emphasize the definite metastatic patterns of these tumors. They are anatomically defined, almost, for a while. That is something that hasn't been generally appreciated and is true of cancer anywhere in the body. We know today that a tumor in a given location has a distinct and definite and predictable pattern of metastasis. It is as true of head and neck cancer as it is of variously involved pulmonary segments.

I think this paper illustrates another point—that clinical research in cancer is at least passing through adolescence and about to come of age, in that we are finally studying thoroughly our causes of failure rather than bragging about our few successes.

Drs. McCort and Robbins didn't emphasize the potential of venous metastasis in bronchogenic cancer. This is, of course, one of the five vein-invading cancers and such invasion is the mechanism of their wide dissemination, so that lymph node metastasis is by no means the only problem. It is the distant metastases that so often stop us surgically.

The presentation by Dr. Harvey on Betatron Cancer Therapy was most interesting. Of course, I am familiar with that work. Part of my function in the Tumor Clinic of the Research Hospital is to review and observe the cases of betatron treatment and follow them. I think the betatron offers real hope and promise for the future, particularly in the deep-seated lesions, as Dr. Harvey brought out. He uses it practically as a surgical method, applying it so accurately and with such complete control that it is almost like a scalpel in his hands. The results are quite surprising from the standpoint of comparisons with conventional irradiation.

Dr. Harvey has, however, the same problems that we have in surgery. Where tumor has totally replaced an organ or part of the organ, if we destroy the tumor, mediastinitis is going to be a serious problem, in the case of an esophageal lesion; a similar situation exists with cancer of the stomach or colon. I think we will still have to use surgical methods, to a certain extent, in advanced cases where the wall of the bowel or the esophagus has been completely replaced by tumor because, as you all know, you can produce perforation of the stomach, etc., by destroying tumor that has replaced the wall.

Radiologists are also faced with the same problem of dissemination that surgeons have in inaccessible lymph node involvement and venous dissemination to distant sites.

In recent years surgery has so advanced that sometimes I think it has almost passed its point of usefulness. With antibiotics, better understanding of fluid balance, shock therapy, blood replacement, etc., we have been able to do things that were undreamed of even a few years ago. I think we have demonstrated how far we can go in excisional tumor surgery. I think it is entirely possible that in some areas the betatron may in the future replace surgical gymnastics with as good or better results.

I think this is illustrated by the present trend in surgery of cancer of the head of the pancreas. The operation has been perfected to a point where a reasonable mortality rate is now achieved. We can do the operation, but we aren't curing pancreatic cancer with it, and I think that in such areas the betatron may replace to some degree extensive excisional surgery.

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[1] Nitrogen Mustard as an Adjunct to Radiation in the Management of Bronchogenic Cancer. Radiology 57: 384–394, September 1951.

[2] Roentgen Diagnosis of Intrathoracic Lymph-Node Metastases in Carcinoma of the Lung. Radiology 57: 339–360, September 1951.

Late Sequelae Following Cancericidal Irradiation in Children

A Report of Three Cases[1]

WALTER T. MURPHY, M.D., and DAVID L. BERENS, M.D.

Buffalo, N. Y.

CANCERICIDAL irradiation in infants and children almost always induces certain permanent tissue alterations or deformities. Such effects are usually not preventable if a clinical cure is the goal of the therapeutic procedure. The most outstanding sequela is interference with bone development.

The influence of radiation upon the centers of ossification is well known (1–6). It may be summarized as follows. Every epiphyseal center has a characteristic rate of growth. This is altered by radiation to a degree dependent upon the age of the patient and the dose delivered to the epiphyseal center. Initial damage is shown by the disappearance of osteoblasts, severance of spongy bone from the epiphyseal cartilage, and cessation of growth. With clinically safe therapeutic doses of radiation, growth is resumed, although in an abnormal manner. Heller (7) demonstrated resumption of bone growth in rats even after injections of radium. Although this would indicate acquired radioresistance, premature termination of growth eventually results, through alteration of both its rate and the period over which it occurs. Microscopically this would be illustrated by absence of cartilaginous columns, with irregular and relatively acellular calcification.

It is the purpose of this paper to report irradiation changes in bone growth in three children who were treated for different types of cancer at the ages of four months, one year, and nine years. All are now alive without evidence of malignant disease twelve years, fifteen years, and nine years, respectively, after irradiation. All roentgen doses, as given, are with backscatter and based upon water-phantom values. Actual bone doses would be higher according to the factors published by Stenstrom and Marvin (8).

CASE I: J. D., a 4-month-old girl, born Jan. 6, 1939, was admitted to Roswell Park Memorial Institute, May 29, 1939. Two weeks prior to admission, the mother had noticed a swelling of the child's right thigh. Examination was done by a pediatrician, who performed a needle-puncture biopsy.

On admission, there was a swelling over the upper two-thirds of the right thigh, firm, fixed, and apparently not tender. No other abnormal physical findings were present. The leukocyte count was 18,000, with 31 polymorphonuclears, 7 eosinophils, 41 small lymphocytes, and 10 monocytes.

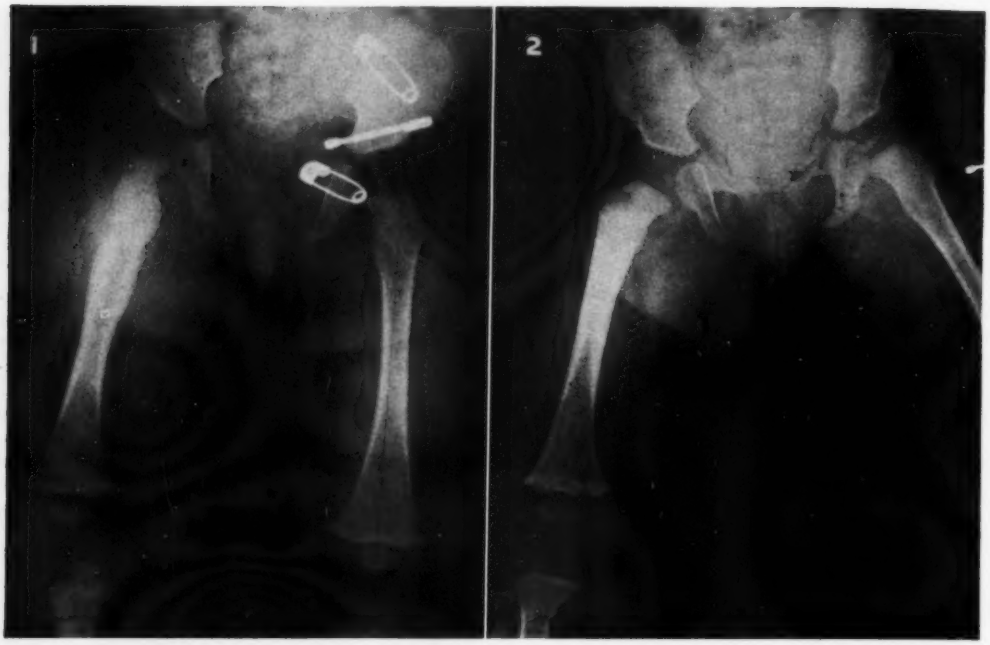
An anteroposterior roentgenogram of the pelvis and femora (Fig. 1) showed a concentric fusiform swelling in the proximal half of the right femoral shaft. The cortex was thickened, with definite laminations. There was evidence of destruction and possible fracture of the cephalad portion of the tumor. The remainder of the visible skeleton revealed no gross abnormalities. The impression was that the findings were compatible with a Ewing's tumor.

The pathological findings were reported by Dr. A. Thibaudeau of the Roswell Park Memorial Institute. A smear of tissue obtained by needle puncture and stained by hematoxylin and eosin showed red blood cells and a tremendous number of round cells occurring in large plaques and independently throughout. Some fragments of necrotic bone were also included. The histologic diagnosis was difficult from this type of preparation. It seemed evident, however, that the collections of round cells represented a malignant neoplasm, possibly a Ewing's tumor.

A pretreatment review of this material by Dr. Fred Stewart (9) of Memorial Hospital, New York City, brought this reply: "I know of no way to determine the exact nature of malignant round-cell tumors from smears. In a situation like this I merely say: This is a malignant tumor; the subject is four months old; the possibilities in the case are Ewing tumor, metastatic retroperitoneal neurocytoma; metastatic retinocytoma. You will have to decide on clinical grounds."

On the basis of these pathological interpretations radiation therapy was begun on *June 9* and continued to *July 1, 1939* (23 days) at 200 kv.p. (h.v.l. 0.9 mm. Cu), 40 cm. skin-target distance, with anterior and posterior portals, 8 × 10 cm., centered

[1] From Roswell Park Memorial Institute, Buffalo, N. Y. Accepted for publication in May 1951.



Figs. 1 and 2. Case I. Fig. 1. Before treatment. Fig. 2. Almost four months after treatment.

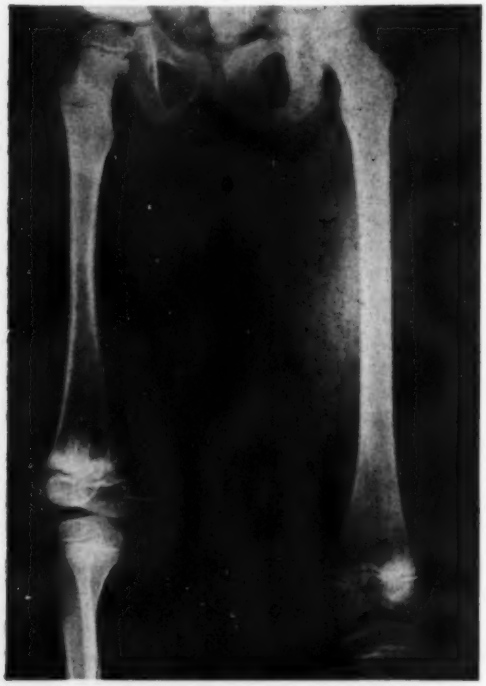


Fig. 3. Case I. Five years after treatment.

over the junction of the upper and mid thirds of the right femur. Treatment was given as follows:

250 r to one port each day for 5 cycles
300 r to one port each day for 4 cycles
400 r to one port each day for 1 cycle

The totals doses were:

Total surface dose to one port	3,944 r
Total dose to center of femur	4,258 r
Total dose to proximal epiphysis of femur	3,778 r
Total dose to distal epiphysis of femur	1,889 r

On *Oct. 20, 1939*, re-examination of the pelvis and right femur in the anteroposterior projection showed considerable decrease of the fusiform swelling of the proximal half of the femur (Fig. 2). There was marked thickening of the cortex with no evidence of destruction or fracture. The femoral neck appeared foreshortened. The femoral capital epiphyseal center of ossification had appeared but was about one-half the size of its mate.

In *January 1940*, the child walked, at eleven months of age.

In *June 1940*, one year after treatment, muscle atrophy of the right thigh was evident.

On *Sept. 15, 1944*, an anteroposterior view of the femora (Fig. 3) revealed definite shortening on the right, with accentuation of tubulation. There were pronounced atrophy and hypoplasia of the shaft and surrounding soft tissue. The femoral neck was

fore-shortened, but the head appeared to be well developed and the proximal epiphysis showed no abnormalities.

The right distal femoral epiphyseal plate was widened, with marked irregularity and sclerosis of the adjacent metaphysis.

On *Oct. 10, 1947*, anteroposterior and lateral views of the right distal femur, including the knee joint, showed atrophy and hypoplasia of the bone and soft tissue. Irregularity of the distal femoral epiphysis, with sclerosis of the metaphysis, persisted. The epiphyseal plate was narrowed and suggested premature closing.

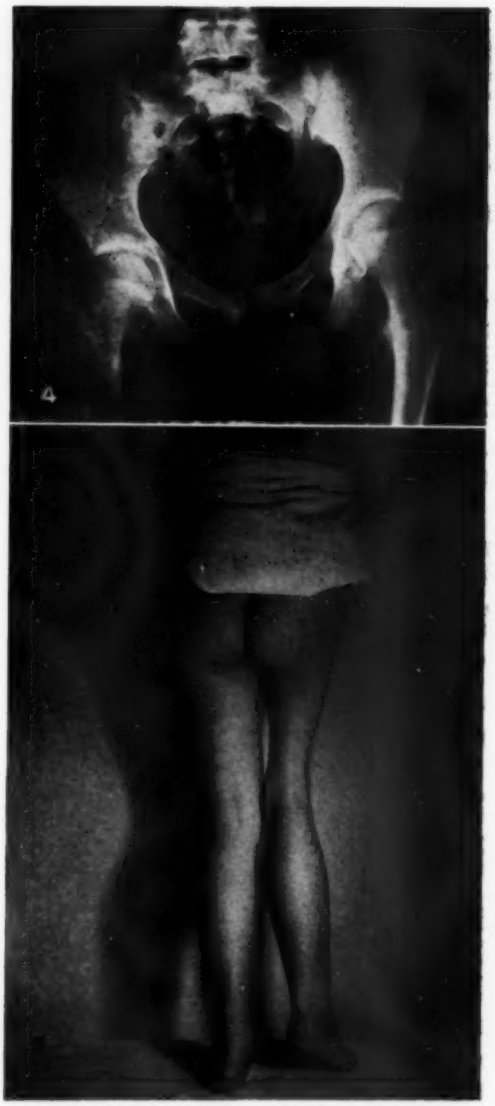
On *Nov. 9, 1948*, roentgenograms, as part of the Goldstein (Rochester) technic to determine the amount of shortening, revealed definite shortening of the right femur with irregularity and early closing of the distal femoral epiphysis. Irregularity of the proximal tibial epiphysis with hypoplasia of the upper tibia was also noted.

On *Jan. 29, 1949*, an epiphyseal arrest operation was performed on the distal end of the left femur at the Strong Memorial Hospital (Rochester, N. Y.). At this time there was a 5-inch shortening in the right lower extremity.

On *Aug. 25, 1950*, an anteroposterior view of the pelvis, including the upper femora (Fig. 4), showed normal development of the pelvic bones and minimal hypoplasia of the right femoral head, neck, proximal shaft, and surrounding soft tissues. At this time there was about 3 inches shortening of the right lower extremity.

The patient began menstruating in May 1950. At the present time the skin over the right thigh is dry and atrophic. There are minimal subcutaneous fibrosis and marked atrophy of the muscles of the right thigh (Fig. 5).

A recent review (Jan. 19, 1951) of this case by Dr. Fred Stewart (10) of New York City disclosed his opinion that the pathological possibilities were the same as those stated earlier. He cited the fact that there are recorded cases where a metastatic neuroblastoma has disappeared or matured into a benign-looking neuroma. "Hence," he says, "it would appear that neuroblastic cells may rarely disseminate in the very young and yet the individual may survive. Frankly I am more impressed with that possibility in your case than with the possibility that you have a Ewing's tumor."



Figs. 4 and 5. Case I. Eleven years after treatment.

CASE II: P. S., a 2-year-old female, born Aug. 30, 1935, was admitted to Roswell Park Memorial Institute on Aug. 31, 1937. When she was eleven months old (July 1936) her mother had discovered a "lump" in the abdomen (Fig. 6). At the Buffalo Children's Hospital, retrograde pyelography revealed a large mass in the region of the left kidney (Fig. 7). There was marked caliectasis of the left upper pole. The soft-tissue mass extended to involve the lower pole. An exploratory operation (July 30, 1936) revealed a non-removable tumor of the left kidney. Biopsy material was interpreted at that time by two different pathologists as Wilms' tumor. The first course of x-ray therapy was given at the Buffalo Children's Hospital from *Aug. 8, 1936 to April 29, 1937*. The factors were: 140 kv.p. (h.v.l. 0.5 mm. Cu); skin-target distance 40 cm; port, anterior left and mid abdomen from tip of xyphoid to groin (exact measurements not available). Treatment was given in increments of 100 r on Aug. 8 and 18, Sept. 2 and 28, Nov. 3, 9, 16, and 26, Dec. 14 and 21, 1936, April 8, 15, and 29, 1937.

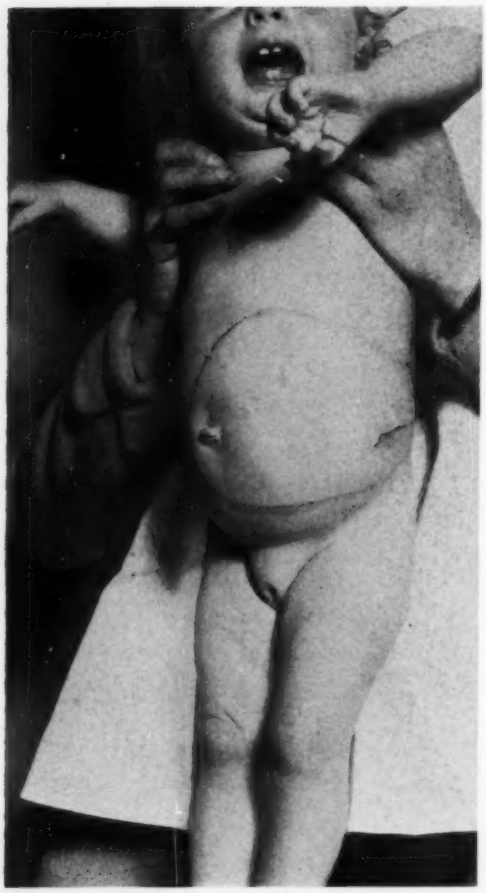


Fig. 6. Case II. Patient at one year of age, prior to treatment. Courtesy of Buffalo Children's Hospital.

Total surface dose	1,300 r
Total dose at 5 cm. depth (tumor mass)	800 r (estimated).
Total dose to vertebral column (left side)	160 r (estimated).

On *Nov. 25, 1936*, a second attempt to remove the tumor failed.

The child was admitted to the Roswell Park Memorial Institute on Aug. 31, 1937. Physical examination revealed a large nodular tumor occupying the left abdomen. The entire abdomen was distended with fluid.

X-ray therapy was given from *Aug. 31, 1937, to Jan. 5, 1938* (128 days) at 200 kv.p. (h.v.l. 0.9 mm. Cu); skin-target distance 50 cm.; 3 ports, anterior left abdomen (8 × 15 cm.), posterior left abdomen (8 × 15 cm.), and lateral left abdomen (6 × 9 cm.). The increments were: 66 r to one port each day for 3 cycles and 132 r to one port each day for 25 cycles.

Total surface dose to each field:

Anterior	4,372 r
Posterior	4,372 r
Lateral	3,498 r
Total depth dose to center of tumor	5,772 r
Total dose to vertebral column (left side)	2,254 r

On *Feb. 3, 1938*, a roentgenogram of the abdomen showed scattered areas of calcification throughout the tumor, which had decreased in size.

On *June 14, 1938*, the tumor was small but very hard.

On *Sept. 11, 1939*, the patient had palpable small nodules, probably mesenteric, as well as a hard nodular tumor in the left abdomen. She had lost weight.

X-ray therapy was again given from *Sept. 11, 1939, to Oct. 27, 1939* (46 days), at 200 kv.p. (h.v.l. 0.9 mm. Cu) and 50 cm. distance; ports, anterior left abdomen (8 × 10 cm.) and posterior left abdomen (8 × 10 cm.). The dose was 100 r to one port each day for 16 cycles.

Total surface dose to one port	2,000 r
Total depth dose to center of left abdomen	1,760 r
Total depth dose to vertebral column (left side)	480 r

On *Nov. 27, 1939*, the patient had gained one pound. There was still a hard calcified mass in the left abdomen, which had not changed in size. No other tumefactions were palpable.

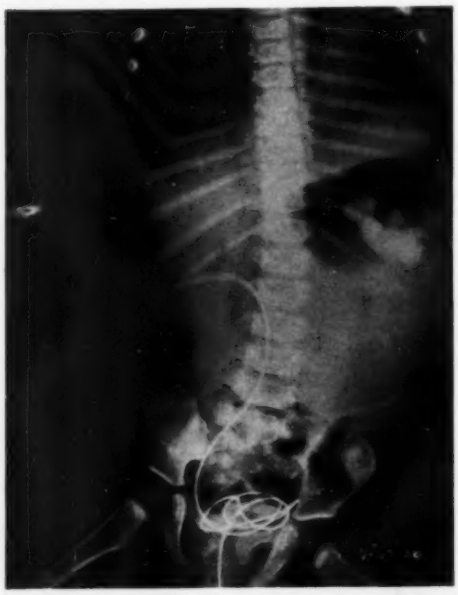
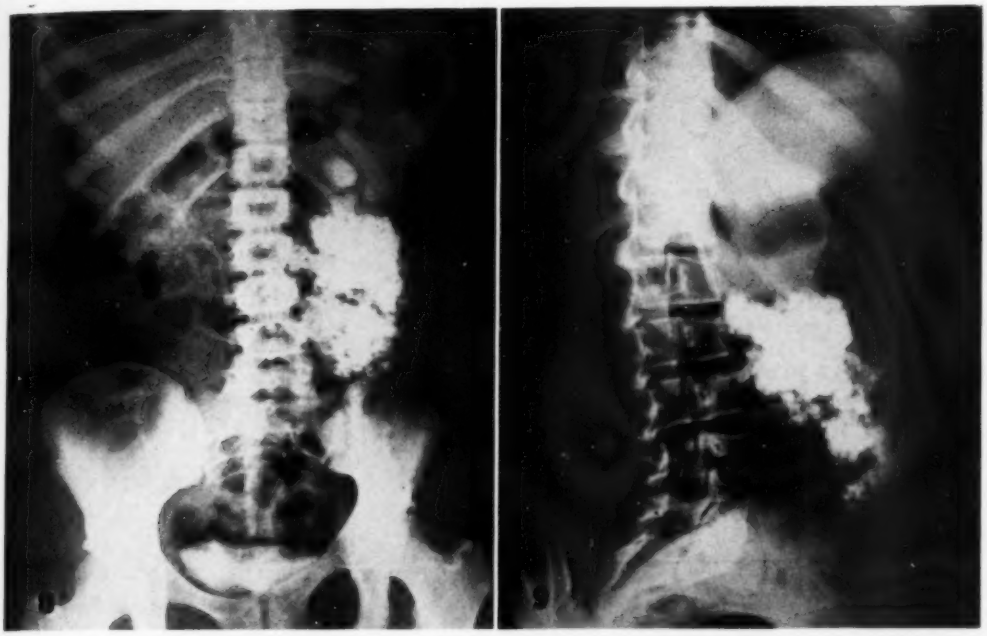


Fig. 7. Case II. Roentgenogram at one year of age, before first course of treatment. Courtesy of Dr. G. N. Scatchard, Buffalo Children's Hospital.



Figs. 8 and 9. Case II. Fig. 8 was taken at fourteen and one-half years and Fig. 9 at fifteen and one-half years of age, eleven and twelve years after the last course of irradiation.

In *July 1947*, when almost twelve years of age, the patient began menstruating.

On *Jan. 13, 1950*, intravenous pyelography was done. The thirty-minute film (Fig. 8) revealed normal structure in the collecting system on the right side. The left upper pole showed caliectasis. The pelvis and ureter were not visualized. The lower two-thirds and perirenal tissue were occupied by a calcified mass. Hypoplasia of the lower dorsal and lumbar vertebrae, left hemipelvis, and proximal left femur were noted. The apophyseal centers of ossification of the iliac crests had appeared bilaterally.

On *Dec. 27, 1950*, x-ray examination of the lumbar vertebrae in a left anterior oblique position (Fig. 9) showed poor development of the vertebral rings, especially on the left side, with a decrease in the height of the left lateral borders of the vertebrae. The architecture of the lumbar vertebrae remained relatively intact. There was a 1-inch shortening in the left lower extremity. The skin over the left abdomen—anterior, posterior, and lateral—was dry and atrophic. There was a moderate amount of subcutaneous fibrosis without fixation (Fig. 10). As stated above, menstruation began at twelve years of age, with development of normal secondary sexual characteristics.

The pathological material removed by biopsy in 1936 and then interpreted as Wilms' tumor of the kidney has recently been re-examined. The present diagnosis is neuroblastoma. A description by Dr.

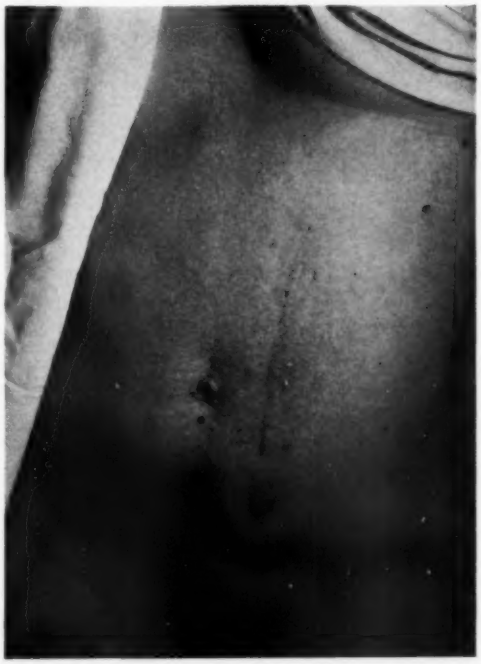


Fig. 10. Case II. Twelve years after last course of radiation therapy; patient fifteen and one-half years old.

K. Terplan, pathologist, is as follows: "Re-examination of the material received, which consists of fibrous and fat tissue surrounding a small lymph nodule, shows that we are unquestionably dealing with a malignant neuroblastoma and not with a Wilms' tumor. There is localized calcification within the tumor."

CASE III: G. P., 9-year-old boy, born Dec. 23, 1932, was admitted to the Roswell Park Memorial Institute on Jan. 14, 1942. In July 1941, the patient's mother discovered a "spot" on the roof of his mouth about the size of a dime and coated white. He received local treatment from his family physician for a fungous infection. On Dec. 20, 1941, a biopsy of the lesion by an oral surgeon showed fibropapilloma. A second biopsy on Jan. 5, 1942, revealed squamous-cell carcinoma of a differentiated cell type.

An ulcerated infiltrating lesion measuring 3 × 3 cm. involved the left hard palate and left alveolar ridge. It extended from the incisor portion of the alveolar ridge back to the junction of the hard and soft palates. The edges were raised, firm and tender. A left molar tooth had been extracted (Fig. 11). There were palpably enlarged lymph nodes in both submaxillary and the left upper cervical regions. Roentgen examination showed increased density in the left antrum without any evidence of bone destruction.

Treatment was given at 400 kv.p. (h.v.l. 5 0 mm. Cu), with 50 cm. skin-target distance, as follows:

Jan. 16 to March 2, 1942 (46 days): To lateral right and left cheek ports, 20 sq. cm. (round); 300 r to one port each day for 15 cycles.

March 3 to March 12, 1942 (10 days): To anterior left cheek port, 10 sq. cm. (round); 300 r each day for 8 treatments.

Total surface dose	
Right and left lateral cheek	4,995 r
Left anterior cheek	2,400 r
Total depth dose in center of hard palate tumor	4,782 r
Over-all treatment time	56 days

Figure 12 shows the boy's appearance following treatment.

On *Feb. 27, 1951*, nine years after irradiation, there was no recurrence of the tumor. There were, however, both clinical and roentgen evidence of retardation of growth of the left maxilla as compared to the right. The left hard palate showed three perforations (Fig. 13). The skin of both the right and left cheeks was dry, with epilation in treated areas. The muscular atrophy of the cheeks was greater on the left side. Although the patient's father has a "lean" face, it is evident from the illustration (Fig. 14) that the pinched appearance of the cheeks is worse on the left side, which received more radiation than the right.

DISCUSSION

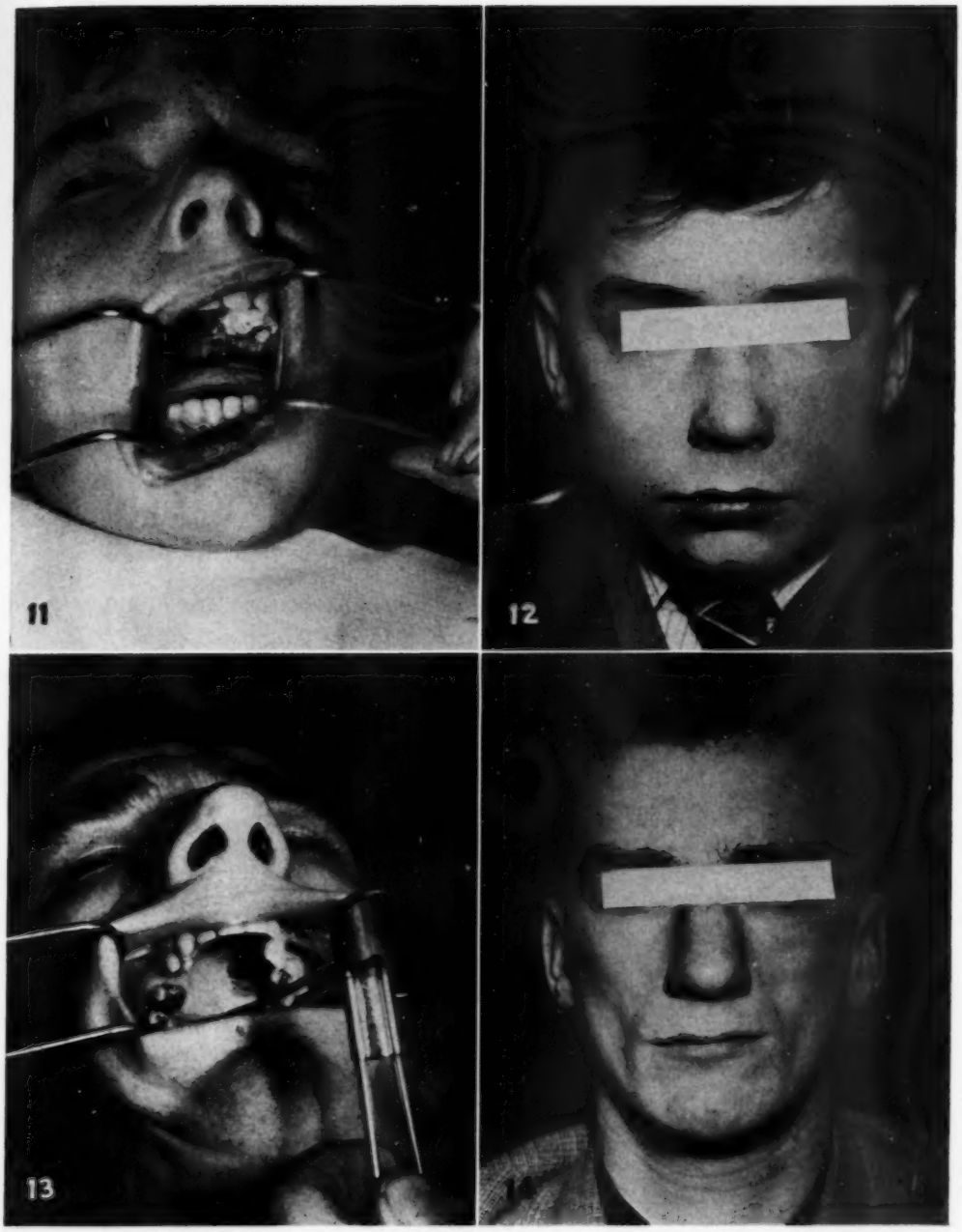
Three patients with malignant disease in childhood received intensive courses of radiation and have lived without clinical evidence of active cancer for twelve, fifteen, and nine years. In all instances permanent structural and growth changes occurred.

In Case I, the roentgen evidence shows more severe changes in the distal epiphysis of the femur, even though it was only on the fringe of the x-ray beam as contrasted to the proximal end, which was in the main field of irradiation. This is probably due to the relative dependence of radiobiological changes upon the inherent characteristic growth rate of an epiphyseal center. The distal femoral epiphysis supplies about 60 per cent of the longitudinal growth of the femur and is thus a much more active center than the proximal femoral epiphysis. It is obvious that a dose of 1,889 to 4,258 r applied within twenty-three days did not cause complete cessation of growth but did alter the bone growth mechanism to the point of deformity of architecture and premature closing of the epiphysis.

Heller (7) has stated that "the best histological indicator of bone damage is the reparative process. When the growth processes were resumed, they were more abnormal, started later, and took longer to reach a certain level after the higher doses and after certain agents."

In Case II, although the primary centers of growth in the ilium were affected, the appearance of the apophyseal center of ossification was not delayed or prevented, as seen in the roentgenogram displaying identical ossification centers along both iliac crests. It is remarkable that there was not more deformity of the vertebral column, since much radiation reached the vertebral centers of ossification. The influence of radiation upon such a center of growth is well illustrated by a case reported by Arkin et al. (11).

In Case III the deformity of the left maxilla is attributable to the greater amount of radiation received on that side.



Figs. 11–14. Case III. Fig. 11. Before treatment. Fig. 12. On last day of treatment. Figs. 13 and 14. Nine years after treatment.

CONCLUSION

Cancericidal irradiation in infants or children will induce permanent somatic tissue changes, manifested by retardation of bone growth, deformity of muscular-bony architecture, atrophy and scarring of skin, and fibrosis of subcutaneous tissues. These changes cannot usually be avoided if a clinical cure is the goal of the radiological procedure.

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SUMARIO

Secuelas Tardías Consecutivas a la Irradiación Cancericida en los Niños: Tres Casos

La irradiación cancericida en las criaturas y niños evocará alteraciones permanentes del tejido somático, traducidas por retardo de la osteogenia, deformidad de la arquitectura óseomuscular, atrofia y escarificación de la piel y fibrosis del tejido subcutáneo. Por lo general, no cabe evitar esas alteraciones si la curación clínica constituye la meta del procedimiento radioterapéutico.

En los 3 casos comunicados, hubo alteraciones osteogenéticas consecutivas a la irradiación administrada en diversas formas de cáncer. Todos los enfermos están vivos al cabo de períodos de tiempo de 12, 15 y 9 años, respectivamente.

Una niñita de cuatro meses fué tratada por tumor del muslo derecho. Las alteraciones irradiatorias fueron más intensas en la epífisis distal del fémur derecho, culminando en cierre prematuro de la epífisis y por fin acortamiento del miembro. En el segundo niño, de un año de edad, con un tumor abdominal considerado como neuroblastoma, aparecieron alteraciones de la columna vertebral, con algún acortamiento del miembro inferior izquierdo. El tercer enfermo, varón de nueve años, tenía un tumor del lado izquierdo del paladar duro y del surco alveolar. En el lado izquierdo, que recibió una dosis más alta de radiación, sobrevinieron retardo del desarrollo del maxilar y atrofia muscular de la mejilla.

Beam-Directed High-Dosage Radiotherapy of Bronchogenic Carcinoma[1]

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THE VARIED AND numerous reports on the efficacy of radiation therapy in bronchogenic carcinoma have prompted the author to record the results of accurate beam-directed radiotherapy administered in high dosage to a group of patients with proved inoperable bronchogenic carcinoma.

A review of the literature revealed no two reports with comparable selection of cases, methods of treatment, or grouping of cases that would permit satisfactory comparative analysis. One of the most comprehensive statistical reviews is that of Overholt and Schmidt (6). In their series, 1932–1948, the survival period was calculated from the time of diagnosis to death from the disease. The average survival period of 148 patients not explored was 4.4 months. The average survival period of 102 patients in whom the tumor was found to be inoperable on exploration was 7.0 months, and of those with resection, but with gross extension or lymph node involvement, 10 months. In the entire series no patient who died of the disease lived longer than 30 months after diagnosis. Overholt and Rumel (5) found that the average life expectancy of inoperable patients who received radiotherapy was only two-thirds that of untreated patients. Graham (3), Steiner (10), and Portmann (7) concluded that radiotherapy did not prolong life.

Shorvon (9) reported a series of 213 cases observed between 1942 and 1946. Of these, 23 were treated palliatively and 111 received radical radiotherapy. The non-irradiated patients survived an average of 6.5 months. The average survival for the group treated with palliative irradiation was 11.5 months. Of the 111 patients receiving radical radiotherapy, 52 per cent died within six months, and the average survival was 15.5 months. Not one radically treated patient survived more than three years. It must be noted, however, that in 92 of the 213 cases a positive pathological diagnosis was not obtained. Radiotherapy was administered chiefly by the Dobbie pin and arc multiple-field technic. A tumor dose of 5,500 r was delivered in five to six weeks. Leddy and Moersch (4), reporting their results in 250 cases of proved bronchogenic carcinoma, showed radiotherapy to be an excellent method of palliation. Without it life expectancy was said to be, at most, one year. Tenzel (11) reported an average survival period for irradiated patients of 15 months compared to 10 months for untreated patients.

The present report covers 12 cases of proved inoperable bronchogenic carcinoma treated from December 1947 to December 1948. The radiotherapy was administered by the multiple-port technic modified after that of Dobbie (2) and Demy (1). The treatment fields were determined by means of the localizing protractor, the application of which is well described by Demy. This method permits accurate localization of the tumor, accurate direction of the radiation beam, delivery of a cancericidal tumor dose, and maintenance of skin dose well below tolerance. The volume of tissue exposed to high dosage is minimal.

With the patient in the treatment position, the lesion is accurately localized by roentgenography. Information is also obtained by thoracotomy when available, and by fluoroscopy, laminagraphy, and contrast studies when indicated. Multiple fields are arranged radially about the lesion as an axis, so that the center of the port corresponds to the center of the lesion.

[1] From the Department of Radiotherapy and The Chest Service, Mount Sinai Hospital, New York, N. Y. Accepted for publication in May 1951.

TABLE I: SUMMARY OF CASES

Case	Age and Sex	Location	Pathology	Thoracotomy	Why Inoperable	Tumor Dose	Number of Months After Onset of Symptoms	Survival After Diagnosis (months)	Remarks
1.	56 M	L.U.L.	Immature squamous-cell carcinoma	Yes	Extensive invasion of hili	6,815 r/69 days	31	26	The patient was markedly dyspneic following radiotherapy. As the left pulmonary vascular bed decreased in volume due to fibrosis, his dyspnea decreased. He was a useful member of society and comfortable for almost two years following radiotherapy. Three months before death he could walk eight blocks without dyspnea, and work several hours per day.
2.	46 M	R.U.L.	Immature squamous-cell carcinoma	No	Involvement of superior vena cava; right phrenic nerve paralysis	6,600 r/30 days	36	26	This patient had a most striking response to radiotherapy. When first seen, he was almost completely bedridden as the result of a superior vena cava obstruction. He had 23 months excellent palliation with a relatively normal life, restricted only by moderate exertional dyspnea, and worked eight hours a day most of the time. Following this he had a four months downhill course to death. Because of this patient's size, an average of 800 r (air) was given daily without difficulty to complete radiotherapy in one month.
3.	57 M	R.U.L.	Squamous-cell carcinoma	Yes	Mass adherent to mediastinum with many large lymph nodes	7,260 r/40 days	19	12	Moderately severe dyspnea persisted following radiotherapy and restricted the patient's activities. He was asymptomatic at rest and lived comfortably for the major part of his remaining eleven months.
4.	55 M	L.L.L.	Squamous-cell carcinoma	No	Carina biopsy positive for squamous-cell carcinoma	7,100 r/45 days	14	8	Radiotherapy probably had no significant influence on the course of the disease.
5.	43 F	L.U.L.	Immature squamous-cell carcinoma	Yes	Massive adhesions to aorta and chest wall	6,600 r/41 days	29	20	Radiotherapy relieved the chief complaint of severe chest pain for fifteen months, and the patient lived comfortably except for mild dyspnea until the terminal downhill course.
6.	56 M	R.U.L.	Immature squamous-cell carcinoma	Yes	Extensive mediastinal infiltration. Huge hilar nodes.	6,800 r/50 days	26	20	Radiotherapy was started a year after diagnosis. The patient's general condition continued downhill, not significantly altered.

TABLE I: SUMMARY OF CASES—*cont.*

Case	Age and Sex	Location	Pathology	Thoracotomy	Why Inoperable	Tumor Dose	Number of Months After Onset of Symptoms	Survival After Diagnosis (months)	Remarks
7.	52 M	R.L.L.	Epidermoid carcinoma	Yes	Mass adherent to diaphragm, pericardium, mediastinum, inferior pulmonary vein; enlarged lymph nodes	7,300 r/37 days	34	28	Marked emphysema with severe dyspnea was present for years before thoracotomy and radiotherapy. Following radiotherapy exertional dyspnea continued, with maintenance of the status quo for two years. Additional radiotherapy was given at another institution and death ensued shortly afterward. Radiotherapy probably delayed considerably the progression of the disease.
8.	65 M	R.U.L.	Squamous-cell carcinoma	No	Positive carina biopsy	7,100 r/40 days	9	6	No beneficial effect.
9.	55 M	R.U.L.	Immature squamous-cell carcinoma	No	Positive carina biopsy	7,100 r/39 days	8	5	No beneficial effect.
10.	63 M	R.L.L.	Squamous-cell carcinoma	No	Positive carina biopsy	6,475 r/39 days	20	12	Before radiotherapy the patient was unable to work. Following therapy he was gainfully employed for five months.
11.	62 M	R.M.L., R.L.L.	Immature squamous-cell carcinoma	No	Positive carina biopsy	5,700 r/27 days	12	8	Although the survival period was not prolonged, this patient had significant regression of symptoms and returned to active productive living for six months.
12.	69 M	R.U.L.	Squamous-cell carcinoma	No	Poor physical condition. Extension demonstrated by x-ray.	6,162 r/44 days	21	18	Radiotherapy caused marked regression of symptoms and diminution in size of the pulmonary mass. The status changed from absolute bed rest due to hypertrophic pulmonary osteopathy, weakness, and chest pain, severe enough to make patient inoperable, to comfortable ambulation for eighteen months.
Average for 12 Cases							21.6	16.0	

By use of the localizing protractor, the angle for any point on the arc can be determined readily, and by this means it becomes possible to direct a radiation beam through the center of the field and the center of the lesion. In general, seven to eight portals are used, extending around the hemithorax and crossing the midline to the contralateral parasternal and paravertebral areas. In order to decrease the total volume dose, the most effective fields receive the largest skin doses. The field arrangement does not encompass the entire thorax because the efficiency of the contralateral ports is poor. In addition, it is undesirable to irradiate the contralateral normal lung. The accuracy of all fields is verified by roentgenograms utilizing the therapy machine with the patient in the treatment position. We believe this procedure is imperative in positioning these patients for accurate beam-directed therapy.

In all cases the physical factors were 400 kv., h.v.l. 4.1 mm. Cu, and target-skin distance 63 cm. or 70 cm. Two opposing fields were treated daily. The air dose was adjusted so the same tumor dose was administered each day. The latter was arbitrarily set at 250 r. This daily dose is necessary to complete therapy in five to six weeks. The field size was variable, but rarely exceeded 8 × 15 cm. It was determined as a space relationship perpendicular to the radiation beam, and not the corresponding irregular skin counterpart.

Quimby (8) made depth-dose measurements in lungs of cadavers and showed that the depth dose is greater and the skin dose is less than for comparable fields in a masonite or water phantom. In a well aerated lung, a deep-seated tumor may have received as much as 20 to 30 per cent more radiation than the conventional calculations reveal. This phenomenon was verified in our laboratory. We have arbitrarily added 10 per cent to all depth-dose determinations to compensate partially for this inherent error.

In order to deliver tumor doses of 6,000 to 7,000 r in five to six weeks, 600 to 900 r must be the daily total air dose through an approximate area of 120 sq. cm. Very little radiation sickness was encountered. In most patients a sense of well being developed. Only two patients lost weight, and several gained during the course of therapy. Dysphagia was one of the common complaints. This appeared early and usually cleared as therapy was continued. The usual supportive measures were employed. Penicillin was given when indicated. All patients but one remained ambulatory.

Table I is a summary of the case reports.

The average survival period of 16 months following diagnosis is comparable to the 15.5 months average survival in the radically treated group reported by Shorvon, whose method of treatment is similar to that used in this series.

SUMMARY

1. Twelve cases of proved inoperable bronchogenic carcinoma were treated with beam-directed radiotherapy to minimal tumor doses of 5,700 to 7,300 r. The average survival time following the onset of symptoms was 21.6 months, and following diagnosis 16.0 months.

2. The results of this small series suggest that the survival time is prolonged following high-dosage beam-directed radiotherapy.

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SUMARIO

Radioterapia de Alta Dosis y Haz Dirigido en el Carcinoma Broncógeno

Doce casos de carcinoma broncógeno inoperable bien comprobado recibieron la roentgenoterapia con la técnica de varias puertas de entrada. Los campos terapéuticos fueron determinados por medio del protractor localizador de Demy (Radiology **51:** 89, 1948), que permite la localización exacta del tumor, el encarrilamiento exacto del haz de rayos y la entrega de una dosis cancericida con una baja dosis cutánea. Empleáronse siete a ocho puertas que se extendían alrededor del hemitórax. Los factores fueron: 400 kv.; capa de hemirreducción de 4.1 mm. de Cu; distancia 63 ó 70 cm. La dosis tumor diaria entregada a través de dos campos opuestos fué de 250 r hasta llegar a una dosis tumor total de 6,000 a 7,000 r. La sobrevivencia media representó 21.6 meses a partir de la iniciación de los síntomas.

The Esophagus and Mediastinal Lymphadenopathy in Bronchial Carcinoma[1]

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ROENTGENOLOGIC examination of the posterior mediastinum is aided by visualization of the esophagus to such a degree that the latter may rightly be called the roentgenologist's probe of the mediastinum. Through observation of the barium-filled esophagus much information can be obtained about masses in the neck and in the posterior mediastinum down to the diaphragm, such as goiter and prevertebral and paravertebral inflammatory and neoplastic lesions. Congenital and acquired cardiovascular abnormalities involving the aorta and its branches, the left auricle, or the left ventricle, and pericardial effusion are common conditions, the search for or definite establishment of which requires esophageal visualization. Furthermore, because of the wealth of information thus obtainable, routine examination of the esophagus during chest fluoroscopy is made in the event of pulmonary consolidation, pleural effusion, or an abnormal mediastinal shadow not satisfactorily accounted for. An esophagus normal in position, width, and contour, with unobstructed passage of the contrast medium, provides fairly good evidence of the absence of gross posterior mediastinal abnormalities. Routine examination of the esophagus has been found particularly useful in the detection of mediastinal lymphadenopathy in malignant lesions of the lung, especially bronchial carcinoma.

With the patient erect, standing or sitting, one or two swallows of barium paste of thick consistency suffice for the examination. In the recumbent position, resulting in slower passage, thinner barium suspensions, such as are used in the examination of the stomach, may serve. Left and right oblique positions in progressive rotation give the best views; additional information is sometimes obtained with straight postero-anterior or lateral projections. The fluoroscopic impressions are recorded by spot films. Standard roentgenograms in the oblique positions or added special views according to the fluoroscopic findings may complete the examination.

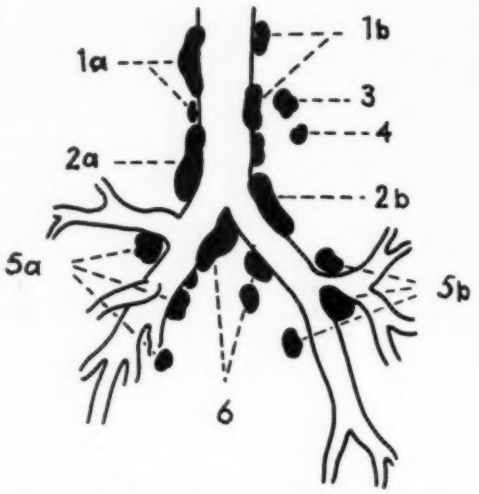

Fig. 1. Diagram of mediastinal lymph nodes after Engel and Rouvière. 1a and 1b. Right and left paratracheal nodes. 2a and 2b. Right and left tracheobronchial nodes. 3. Aortic nodes. 4. Ductus arteriosus node. 5a and 5b. Right and left "hilar" nodes. 6. Bifurcation nodes.

The normal and pathologic narrowings and displacements of the esophagus at the level of the aortic arch, the intersection with the left bronchus and the descending aorta, the left auricle and ventricle are listed in textbooks. Little attention, however, has been paid to compression by enlarged lymph nodes at the bifurcation angle (Fleischner, Lenk, Evans). The anatomic arrangement of the mediastinal

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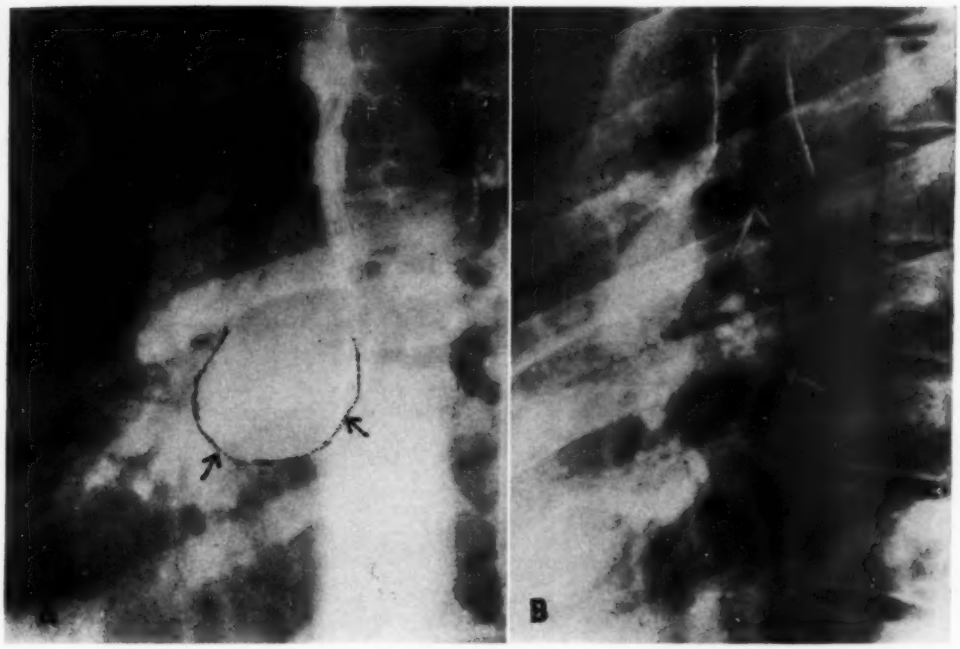

Fig. 2. A. Left oblique view of the chest (retouched) of a child with extensive postprimary tuberculous lymphadenopathy. The large mass of lymph nodes in the bifurcation angle is distinctly visible, even without the aid of the esophagus partially filled with barium.
B. Left oblique view of the chest of a child with contracting and partially calcified tuberculous bifurcation nodes.

lymph nodes may be recalled by a diagram based on the findings of Engel and Rouvière (Fig. 1). This shows the right and left paratracheal nodes, right and left tracheobronchial nodes, the groups of aortic and ductus arteriosus nodes, and the hilar nodes in the angles formed by the branches of the right and left main bronchi and the pulmonary arteries on either side. Another group of nodes is located within the bifurcation angle beneath the carina, with a larger subgroup along the right and a smaller subgroup along the left bronchus. In addition, there are individual nodes along the esophagus and the aorta, *i.e.*, the paresophageal and paraortic nodes, as well as the anterior mediastinal or innominate nodes.

Enlargement of mediastinal and hilar nodes can be recognized roentgenologically when they extend into the aerated lung field, change visible landmarks, or encroach upon mediastinal structures visible by natural or artificial contrast. Thus, enlarged paratracheal, tracheobronchial and hilar nodes are usually quite prominent in the sagittal view. If the hilar nodes cannot be distinguished clearly from vascular shadows, oblique views, fluoroscopy, and laminagraphy are of definite value. Enlarged nodes may narrow the air column of the trachea and main bronchi, displace a bronchus, or blunt the bifurcation angle, changes which are clearly visible on roentgenograms of proper penetration. Enlarged bifurcation nodes, which usually do not project beyond the cardiovascular silhouette, would not be suspected from the postero-anterior view except for the rare broadening of the carina. Occasionally, and quite distinctly in children, markedly enlarged bifurcation nodes are visualized in oblique views (Fig. 2). They are best brought into relief, however, by barium-filling of the esophagus.

The esophagus, as it passes slightly to

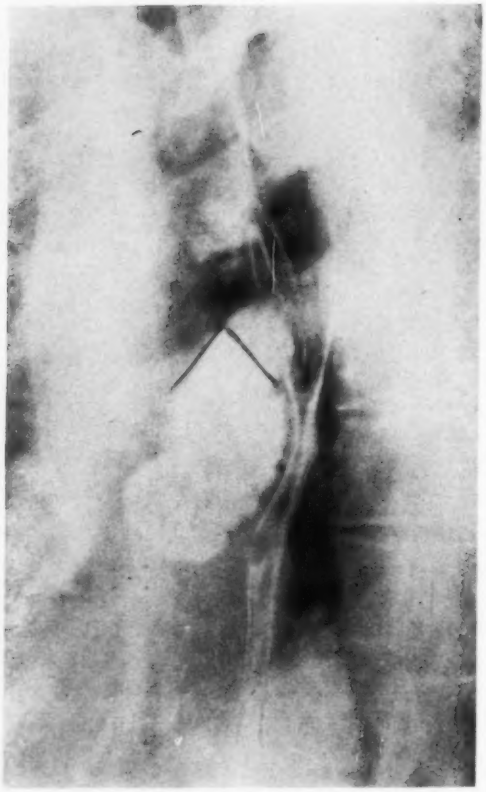

Fig. 3. Large calcified bifurcation nodes in an adult, and their relation to the esophagus. Left anterior oblique position. The carina is marked by black lines. The esophagus lined by barium (retouched) is compressed and slightly displaced to the left posteriorly.

the left of the bifurcation of the trachea, is in close proximity to the nodes in the bifurcation angle. This is also the most common site of traction diverticula of the esophagus, where lymphadenopathy, chiefly tuberculous in origin, extends to the esophageal wall and causes local traction upon the wall in the process of healing and shrinking. Enlargement of the bifurcation nodes is likely to cause compression and displacement of the esophagus. Since the mass of lymph nodes lies anteriorly and slightly to the right, the compression occurs usually at the right anterior aspect of the esophagus and, therefore, is best seen in the left anterior oblique view (Fig. 3). A few examples illustrate these facts.

CASE 1: J. S., male aged 78 years, was admitted for operation for benign hypertrophy of the prostate. The routine preoperative chest film revealed nodular masses in the right hilar region. On further examination, the esophagus was found to be compressed by enlarged bifurcation nodes and to be narrowed, also, in the region below the aortic arch (Fig. 4). In succeeding months the pulmonary consolidation increased and enlargement of the right paratracheal nodes became evident. The patient died within five months after the first observation. At necropsy extensive neoplastic infiltration of the mediastinum was found. The esophagus was adherent to and compressed by the grossly enlarged bifurcation nodes.

CASE 2: J. B., male aged 67 years, showed consolidation of the lower half of the left upper lobe

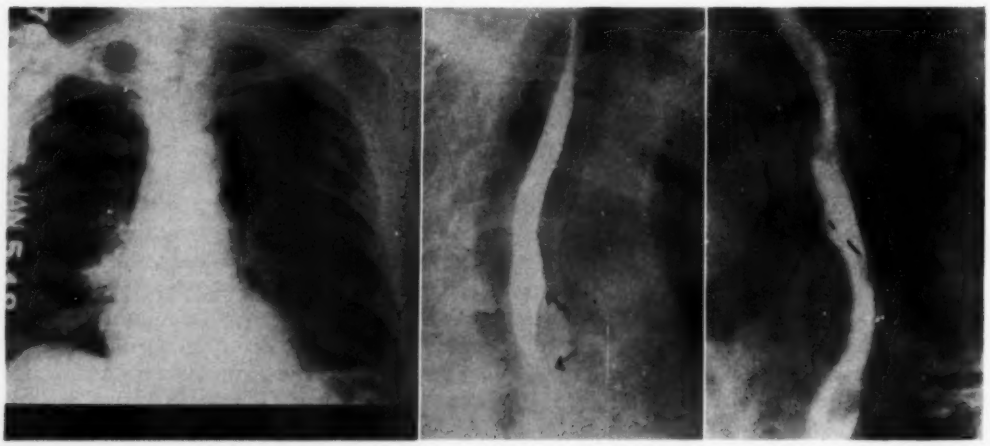

Fig. 4. Case 1: Bronchial carcinoma in the right middle lobe. The right and left oblique views show the impression upon the esophagus by enlarged bifurcation nodes.

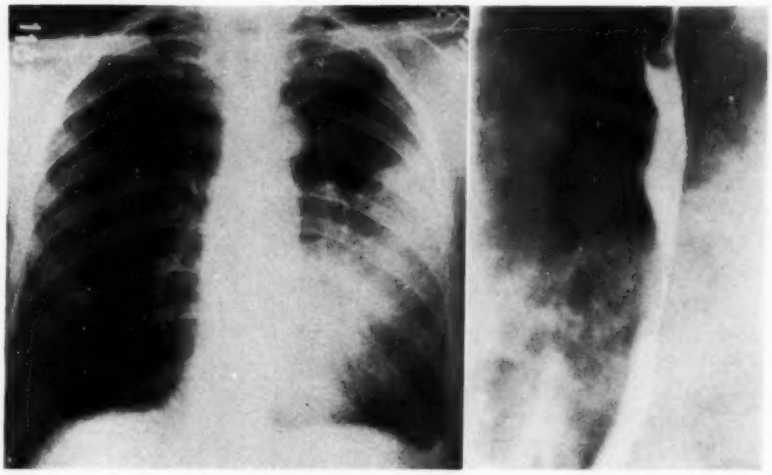

Fig. 5. Case 2: Bronchial carcinoma in the lower half of the left upper lobe. The left oblique view shows the impression upon the barium-filled esophagus by enlarged bifurcation nodes.

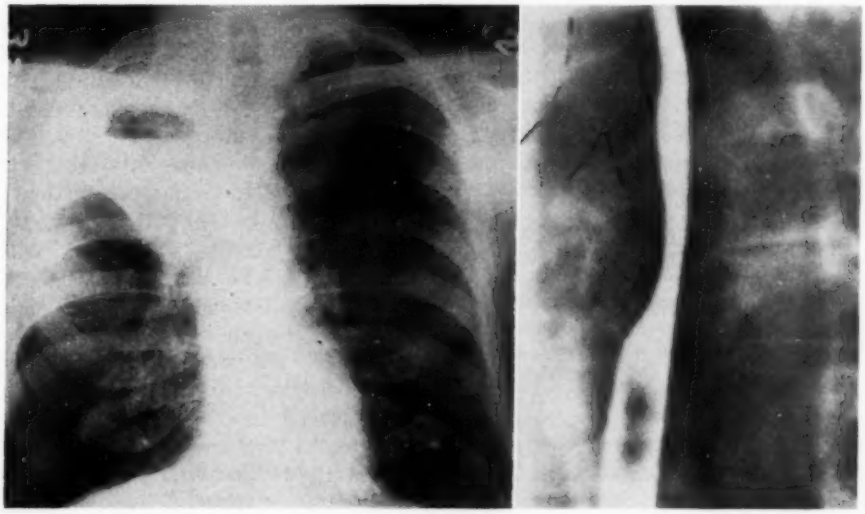

Fig. 6. Case 3: Bronchial carcinoma of the right upper lobe with a large abscess. The enlarged bifurcation nodes are clearly demonstrated in the left oblique view.

including the lingula, a small pleural effusion on the left, and enlarged bifurcation nodes (Fig. 5). Bronchoscopy and bronchoscopic biopsy were inconclusive. Exploratory thoracotomy (Dr. Howard Frank) revealed tumorous infiltration of the lingula and solid infiltration of the lung root. There were several discrete masses of tumor tissue in the mediastinum involving the phrenic and recurrent nerves. Biopsy revealed oat-cell carcinoma. The lesion was not resectable.

CASE 3: A. S., male aged 51 years, was first seen because of pain in the left hip. An extensive metastasis with fracture of the left ischium was found. The chest examination revealed collapse of the right upper lobe, with a large abscess. There was compression of the esophagus by enlarged bifurcation nodes (Fig. 6). On bronchoscopy, narrowing and upward displacement of the right upper lobe bronchus were observed. Though no growth could be seen, the findings were interpreted as consistent with tumor of the right upper lobe. The patient's condition became worse; he had repeated hemoptyses and died at home. No autopsy was obtained. The

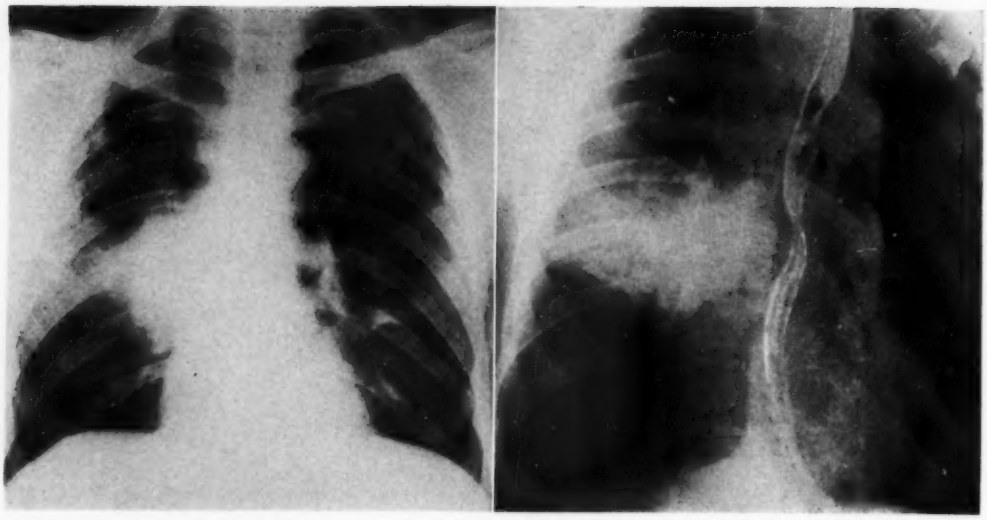

Fig. 7. Case 4: Bronchial carcinoma of the right upper and middle lobes. In the right oblique view the esophagus is displaced anteriorly to the left, indicating that the tumor has grown into the mediastinum.

diagnosis of bronchial carcinoma in this case rests on the clinical and roentgenologic picture and the presence of a bone metastasis.

CASE 4: M. S., male aged 48 years, had a consolidation in the right hilar region involving the upper and lower lobe. The esophagus was narrowed and displaced by a mass lying behind it and to the right (Fig. 7). A biopsy specimen was obtained bronchoscopically and a diagnosis of round-cell tumor was made. Exploratory thoracotomy (Dr. Howard Frank) showed tumor completely infiltrating the hilus and extending directly as a firm nodular mass into the mediastinum, behind the esophagus, and also anteriorly between the esophagus and trachea. The tumor was not resectable.

Comment: In the typical case of enlargement of the bifurcation nodes there is a shallow or moderate indentation of the right anterior wall of the esophagus as seen in the left anterior oblique view. If it is of appreciable depth, its upper and lower end may show a sharp angle. The esophagus at this level may be slightly curved posteriorly and laterally in its entirety. The indentation starts immediately beneath the left bronchus, reaches downward for a distance of about 5 cm., and causes some narrowing of the esophageal lumen. Occasionally there is slight stagnation of barium above the narrowed area, though this is less than with left auricular dilatation; there is no dysphagia. As with any other subclinical narrowing of the esophagus, a bolus may by chance lodge above the constriction, thereby causing acute dysphagia. This is apparently unusual in connection with carcinomatous lymphadenopathy of this early type. The mucosal folds are usually undisturbed, but slight irregularities or rigidity may occasionally be seen at the indented part of the wall.

Intrinsic disease of the esophagus, such as a corrosive stricture, cicatrizing esophagitis, carcinoma, leiomyoma, and other intramural extramucosal tumors, may incidentally be located at the level of the bifurcation nodes. These conditions can usually be recognized by their distinct roentgenologic characteristics. Occasionally, however, the diagnostic features may be less pronounced and differentiation among them and from a compressing extrinsic mass may be difficult. In rare instances, lymph-node metastases or malignant lymphomas (Haudek) grow into the esophagus. Since this occurrence is almost identical with a primary carcinoma of the esophagus, a roentgenologic distinction is impossible. Rarely, also, chronic non-tumorous pulmonary consolidation

may be associated with an unrelated primary lesion of the esophagus, such as a small, infiltrating, non-encircling carcinoma. Such a situation admittedly may present unsurmountable roentgenologic difficulties.

Compression of the esophagus from without may be due to other causes than enlarged bifurcation nodes. The intersection with the left bronchus usually causes only a very shallow indentation of the anterior esophageal wall, which is best seen in the right oblique view. The esophagus may be pressed toward the bronchus, or the bronchus toward the esophagus, by narrowing of the mediastinum, such as is caused by dilatation of the left auricle with lifting of the bronchus or dilatation of the pulmonary artery. The impression upon the esophagus by the left bronchus is often prominent when the esophagus is dilated, whether as a result of atony, cardiospasm, or low organic obstruction. In these instances, the band-shaped indentation or filling defect corresponding to the course and caliber of the bronchus can be easily identified. The compression and displacement of the esophagus by an enlarged left auricle, generalized dilatation of the heart, and pericardial effusion, are well known. Only the enlarged left auricle may displace the esophagus in a way somewhat similar to enlarged bifurcation nodes. The indentation by the dilated auricle also starts immediately beneath the bifurcation, but usually extends for a greater distance downward. The displacement is mostly to the right posteriorly and is usually best observed in the right oblique view; displacement to the left is rare. If doubt exists, roentgenologic and clinical evidence of mitral valve disease, auricular fibrillation, and cardiomegaly may be helpful. Displacement of the esophagus due to left ventricular dilatation, general enlargement of the heart, and pericardial effusion always extends down to the diaphragm.

Greater difficulties may be encountered when the esophagus is displaced to the left posteriorly in the presence of an elongated tortuous descending aorta. In this case the elongated atheromatous aorta bends to the left and posteriorly and the esophagus, with few exceptions, follows its course. This has been explained by some as the result of adhesions between the two structures caused by syphilis or rheumatic disease. It appears, however, that this close relation of esophagus and descending aorta is due to mechanical conditions. The aorta is the only structure of substance in the posterior mediastinum. If the vessel bends to the left posteriorly, due to elongation and dilatation, it distorts the entire mediastinum and carries the esophagus with it. The esophagus is found to follow snugly the right anterior concavity of the aortic tube. This situation, best seen in the left oblique position, is easily recognized. The curve of the esophagus starts just beneath the aortic arch above the left bronchus, and follows the aortic tube smoothly down to the intersection of both structures; the picture is often one of a bayonet-like winding of the esophagus around the right, anterior, and left aspects of the tortuous aorta. With this distortion of the posterior mediastinum, the esophagus deviates from its close relation to the bifurcation nodes and the left auricle and thereby loses its value as an indicator of enlargement of these structures. The esophagus which is distant from the bifurcation nodes is no longer of use as a "mediastinal probe" for the problem in question.

The same is true for any more extensive derangement of the mediastinum, caused by lateral displacement due to pleuropulmonary or intrinsic mediastinal disease. In such instances, it may be difficult or impossible to determine whether an irregularity of the esophagus at the bifurcation level is caused by enlarged lymph nodes or general distortion of the structures. Therefore, the significance of such abnormalities must be carefully weighed.

The bifurcation lymph nodes may be enlarged in inflammatory and neoplastic diseases. Acute respiratory infection, influenza, and virus infection occasionally

cause mediastinal lymphadenopathy. It is more common in chronic suppurative pulmonary disease with or without bronchiectasis. Tuberculosis in children, both the primary complex and early post-primary dissemination, is most commonly accompanied by lymphadenopathy. At later ages, healed tuberculous lymphadenopathy is usually characterized by calcification (see above). Sarcoidosis and other conditions of unknown etiology and difficult identification lead to enlargement of the mediastinal nodes. Any type of malignant lymphoma or leukemia may have deposits in the mediastinum. Metastatic mediastinal carcinoma secondary to primary tumors of the breast and abdominal organs is not rare. It is bronchial carcinoma, however, that spreads most frequently and earliest into the mediastinal lymph nodes.

The significance of the detection of mediastinal lymphadenopathy in bronchial carcinoma must be emphasized. There are two aspects to this problem: diagnosis and therapeutic indication. The roentgenologic syndrome, chronic pulmonary consolidation and mediastinal lymphadenopathy, has been known for a long time as highly suggestive of bronchial carcinoma, in spite of similar syndromes in tuberculosis, chronic pneumonia, Hodgkin's disease, etc. This syndrome, involving mainly the immediately visible nodes and those impinging on trachea and bronchi, has been thoroughly analyzed by Lenk and more recently by Gladnikoff. In addition, enlargement of the bifurcation nodes is most reliably revealed by the effect upon the esophagus. Therefore, it is advisable to examine the esophagus in every case of pulmonary consolidation of doubtful nature. The evidence of lymphadenopathy revealed by compression of the esophagus may add significantly to the other roentgenologic and clinical signs and symptoms of bronchial carcinoma.

With the advent of the surgical treatment of pulmonary cancer, mediastinal lymphadenopathy, formerly considered solely for its diagnostic value, has acquired still another significance. Enlarged mediastinal nodes usually indicate metastatic spread. At times chronic pulmonary suppuration beyond an obstructing bronchial carcinoma and other unknown circumstances may cause congestive and inflammatory swelling of mediastinal nodes not distinguishable from carcinomatous lymphadenopathy; this condition, however, is rare. Gladnikoff found enlargement of mediastinal lymph nodes in 98 out of 219 cases of primary cancer of the lung. Metastatic carcinoma was found in these enlarged nodes at operation or autopsy in all but 3 instances of enlargement recognized by roentgenologic study. For the majority of cases it may be assumed that mediastinal lymphadenopathy in the presence of a bronchial carcinoma is a sign of carcinomatous spread into the mediastinum.

Gladnikoff also analyzed the frequency and location of lymph node metastases in bronchial carcinoma, using the material of Crafoord's clinic. His data define the frequency of involvement of the individual groups as observed roentgenologically. The nodes at the bifurcation were most commonly involved, *i.e.*, 73 times in his series of 98 cases. Exploratory thoracotomy was performed in 64 of these cases and in all but 7 the tumor was found to be inoperable because of extensive involvement of the mediastinum. In those instances of our smaller series where enlarged bifurcation nodes were found and an exploratory thoracotomy was performed, the findings of extensive mediastinal lymphadenopathy and inoperability were confirmed.

In addition to enlarged bifurcation nodes, readily identified by compression and displacement of the esophagus, one may observe enlargement of paresophageal nodes, spread beyond the lymph nodes, or direct invasion into the mediastinum of the primary pulmonary tumor. The resultant distortions of the esophagus are not easily identified: but, correctly interpreted, they strongly indicate diffuse neoplastic involvement of the mediastinum

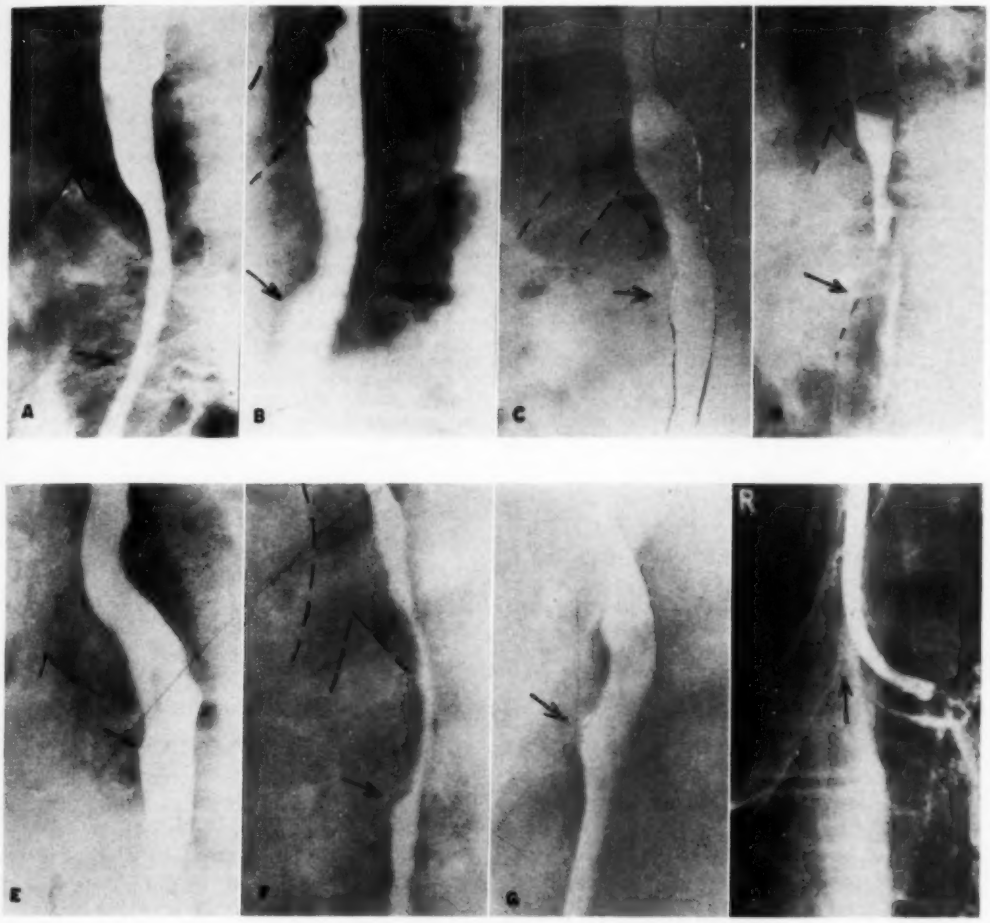

Fig. 8. Seven instances of visualization of enlarged bifurcation nodes by the barium-filled esophagus in proved cases of bronchial carcinoma. The arrows point to the lower end of the indentation.
A. Carcinoma of the left upper lobe. B. Carcinoma of left lower lobe. C. Carcinoma of left upper lobe. D. Carcinoma of left main bronchus. E. Carcinoma of left upper lobe. F. Carcinoma of left lower lobe. G. Carcinoma of left upper lobe. H. Bronchogram of the same case as G to show the sharp carina (simple arrow). The barbed arrow points to the obstructed left upper lobe bronchus. Roentgenologic identification of enlarged bifurcation nodes with the barium-filled esophagus is possible earlier, in most instances, than bronchoscopic establishment of abnormalities, such as blunting and fixation of the bifurcation.

(see Case 4, Fig. 7), especially since the spread of the tumor is usually more extensive than is signalized by a few enlarged lymph nodes. Laminagraphy, through visualization of the trachea, bronchi, and hilar lymph nodes, and angiography, by demonstration of the large vessels of the mediastinum, have contributed considerably to the detailed diagnosis and differential diagnosis of bronchial carcinoma. The simple examination of the esophagus very often yields information clinically sufficient to make the application of more cumbersome methods unnecessary (Fig. 8).

The delineation of operability may vary. Also the aim of the operation—curative or palliative—may change. Nevertheless, the roentgenologic demonstration of extension into the mediastinum is helpful in determining the therapeutic indications and prognosis.

SUMMARY

Roentgenologic observation of the barium-filled esophagus has proved a useful procedure in diagnosis of lesions of the lungs, pleura, and mediastinum. Demonstration of esophageal compression and displacement is of special value for the recognition of enlargement of the mediastinal lymph nodes lying within the angle produced by the bifurcation of the trachea —the so-called bifurcation nodes—which may not be demonstrable otherwise.

Enlargement of the bifurcation nodes may be either inflammatory or neoplastic. It is especially characteristic of bronchial carcinoma and its demonstration in association with chronic pulmonary consolidation is highly suggestive of that diagnosis. It is significant also from the point of view of prognosis and treatment, since it is indicative of carcinomatous spread to the mediastinum.

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SUMARIO

El Esófago y la Linfadenopatía Mediastínica en el Carcinoma Bronquial

La observación radiológica del esófago lleno de bario se ha mostrado útil como procedimiento para el diagnóstico de las lesiones de los pulmones, pleura y mediastino. Posee en particular valor para el reconocimiento de la hipertrofia de los ganglios linfáticos del mediastino que quedan en el ángulo formado por la bifurcación de la tráquea que tal vez no puedan ser observados de otro modo.

Esos ganglios quedan muy cerca del esófago y la hipertrofia de los mismos puede dar por resultado compresión y desplazamiento de este órgano. Como se hallan enfrente y algo a la derecha del esófago, la compresión suele recaer sobre la cara anterior derecha y se observa mejor en una vista oblicua anterior izquierda.

La hipertrofia de los ganglios de la bifurcación puede ser ya inflamatoria o neoplásica. Es en particular típica del carcinoma bronquial y su descubrimiento con los rayos X, unido al de hepatización pulmonar crónica, es muy indicativo de dicho diagnóstico. Reviste igualmente importancia, desde el punto de vista del pronóstico y del tratamiento, pues indica difusión carcinomatosa al mediastino.

An Accurate Method for the Measurement of Radioiodine in the Thyroid Gland by an External Counter[1]

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IT IS POSSIBLE to evaluate the functional state of the thyroid gland using radioiodine, I^{131}, as a tracer material. In theory, examination by this means should be subject to fewer errors and should be more reliable physiologically than measurement of the basal metabolic rate. A variety of procedures (1–10) have been described, but at the present time there is considerable difference of opinion concerning their relative merits. Two aspects of thyroid function can be investigated with I^{131} in the intact patient: the avidity of the gland for iodide and the relative rate of secretion of the iodine-containing thyroid hormone. The former can be determined only by the use of the radioisotope; the latter can be estimated more easily with radioiodine than by biochemical means. In this paper we limit the discussion to the direct measurement of the uptake of radioiodine by the thyroid gland.

The accumulation of radioiodine in the thyroid has been studied in two ways: by *direct measurement* of gamma radiation from the gland by means of an externally located Geiger-Müller (GM) counter, and by *indirect estimation* of the uptake by determination of the total urinary excretion of radioiodine in a specified time (9, 10). It is assumed that the difference between the dose administered and the amount excreted equals the uptake by the thyroid. When a direct measurement is made, the results may be expressed either as "per cent of dose in the gland at time, *t*," or as the rate of accumulation, or "per cent of dose accumulated per hour."

The general acceptance of a radioiodine test for diagnostic purposes will depend upon the development of simple and accurate methods which will be as easy to perform and more reliable than the determination of the basal metabolic rate. The gamma radiation of I^{131} is quite suitable for the measurement of the radioactivity in the gland with a GM counter located at some distance from the neck. Nevertheless, nearly everyone who has attempted to measure uptake in this way has encountered difficulties. The problem has been well stated (1949) by Oddie and Scott (2):

> "External gamma ray measurement . . . has obvious advantages . . . while its difficulties are not apparent until attempts are made to correlate measurements made with different equipment, or in different patients, or to express the uptake reliably as a fraction of the dose administered . . . . These difficulties are caused chiefly by variations in the geometrical distribution of the thyroid gland and in the positioning of the patient in relation to the measurement equipment".

A year later the same authors said:

> "Unfortunately, and in spite of the confidence of some writers, this promising method (*i.e.*, external gamma ray measurement) does not seem to have developed sufficiently to allow clear rules to be stated for interpreting the results."

These quotations are an accurate statement of our own views, and during the past two years the major effort of our laboratory has been directed to the development of a reliable method for the direct measurement of the I^{131} content of the thyroid gland. The method which we describe in this paper has been in routine use, unchanged, for the past year. More than 300 tests have been performed on some 200 patients during that time. In

[1] From the Radioisotope Unit, Veterans Administration Hospital, Hines, Ill. Reviewed in the Veterans Administration and published with the approval of the Chief Medical Director. The statements and conclusions published by the authors are the result of their own study and do not necessarily reflect the opinion or policy of the Veterans Administration. Accepted for publication in May 1951.

The radioactive iodine used in the test conducted was obtained from the Atomic Energy Commission.

addition to the external measurement of radioactivity, we routinely perform radioassay of the first 24-hour urine specimen, determination of the total plasma I^{131}, and of the plasma protein-bound I^{131}.

The accurate measurement of the radioactivity contained in the thyroid gland requires a consideration of the following factors: (1) *geometry*, which includes the shape of the gland and its virtual position in the neck, and the relation of the apparent center of radiation to the detection device; (2) *absorption*, which depends upon the location of the center of radiation in the neck and the amount of tissue which is traversed by the radiation; (3) *back-scatter*, which depends upon the amount and kind of matter that exists around the center of radiation; (4) *background;* (5) *sensitivity of the detector*.

Since gamma rays obey the inverse-square law, the exact distance from the sensitive portion of the detection device to the center of radiation in the gland is critical and should be determined as accurately as possible. It is proper to make a correction for the amount of radiation which is absorbed by the tissue between the center of radiation and the detector, and this can be done only when linear distance is known. Methods for determining the true position of the gland in space with respect to the detection device have been reported by Myant, Honour, and Pochin (4) and by Freedberg *et al.* (6). The method described by Myant's group employs a single shielded counter with which readings are made at six distances from the neck. By applying the inverse-square law, the true position of the gland can be calculated accurately. A constant correction is made for back-scatter (see below), and absorption is neglected. The method of Freedberg's group requires the use of four GM counters arranged symmetrically around the neck at a constant distance. With this arrangement, the geometry becomes a constant, and the actual position of the gland is not important. Since the position is not determined, back-scatter and absorption are neglected. Except for these two groups of investigators, most workers have assumed that the distance from the detector to the skin of the neck can be taken as equivalent to the distance from the effective center of radiation within the thyroid to the counter. This particular assumption can be responsible for errors of as much as 40 per cent in estimates of the percentage of dose in the gland. The linear absorption coefficient for the gamma rays of I^{131} is approximately 3 per cent per centimeter for small thicknesses of tissue.

Because of normal anatomical variations in the shape of the neck and the arrangement of the gland, the amount of tissue which is traversed by the radiation may vary by 3 or 4 cm. in the normal subject, and by more in pathological states. Since most direct external measurements are made at distances where the radioactivity behaves like a point source, the error in the estimation may be increased by 10 per cent or more if absorption is not taken into consideration.

Back-scatter appears to be generally neglected, although it is a significant factor to consider in any measurement of radiation. Myant and his group have studied this matter carefully and apply a constant correction factor of -27 per cent to their measurements. Since the effect of back-scatter is to increase the counting rate, it tends to offset errors resulting from the neglect of the effect of absorption. It is not proper, however, to ignore a phenomenon on this basis.

Every report of a method of external gamma ray measurement emphasizes the necessity of using the same arrangement of the patient and the detector in repeated tests. Most of the methods include special precautions for positioning the tube to assure that it "sees" the entire gland. This is an important detail, since many of the detection devices have a narrow solid-angle response and small errors in positioning the tube with respect to the patient will result in a large reduction of the counting rate. It is the general practice to measure the body or thigh background and

the room background, and to use net counts in the calculation of results. Some of the methods (1, 4) use heavy shields between the patient and the GM counter, but the necessity of this is not well established.

We consider now certain theoretical aspects of the problem of determining the exact location of the center of radiation as a part of the direct measurement of gamma rays by external counters.

THEORETICAL CONSIDERATIONS

When two sources of radiation simulating the lobes of the thyroid gland are measured at distances where the inverse-square law operates, they behave as a single-point source. With the counter described below, a source (or a gland) of any size which might be encountered in clinical practice behaves as a point source at a distance of 20 cm. or more. By taking a series of readings at distances greater than 20 cm., it is possible with an inverse-square plot to determine the distance from the center of radiation in the gland to the sensitive portion of the counter tube. The anatomical centers of the lobes of the thyroid may lie at any distance from 0 to about 6 cm. beneath the skin. Since the centers of the lobes can be considered the source of the radiation, it is necessary to calculate the distance from the skin to the source if an accurate measurement of radioactivity is desired.

The intensity of radiation at a distance where the inverse-square law operates, neglecting absorption and back-scatter, is given by

$$I = I_0/r^2 \qquad (1)$$

For a series of such readings at various distances plotted on a log-log scale the slope of the line, m, is 2 and is given by

$$m = \frac{\log C_i - \log C_j}{\log X_i - \log X_j} \qquad (2)$$

where C_i, C_j, etc., are net counts per minute (observed c/m minus room background) obtained at tube-source distances X_i, X_j. . . at twenty-four hours. Since the values for C_i, etc., and X_i, etc., are not normally distributed, it is necessary to determine m by the method of the major axis of an ellipse of correlation, so that

$$m^2 = \frac{\Sigma(\log C_a - \overline{\log C_b})^2}{\Sigma(\log X_a - \overline{\log X_b})} = 4 \qquad (3)$$

where C_a is any value of C, and $\overline{C_b}$ is the average for all values of C, and $\overline{\log C_b}$ is the average of the logs of all values of C; and X_a is any value of X, etc.

The tube-source distance, X, is

$$X = d + r \qquad (4)$$

where d is the tube-skin distance and r the distance from the skin to the center of radiation in the thyroid gland. It is physically possible for r to vary only from $0 < r < 6$ cm. At the three distances d_i, d_j, and d_k, used in the method described below, the value for the expression $(\log X_a - \overline{\log X_b})^2$ of Equation 3 lies between 0.033 and 0.024.

The value for r is calculated as follows: Three values for d, such as: $d_i = 26$ cm., $d_j = 32.5$ cm., and $d_k = 46.8$ cm., are substituted in Equation 3, using values for r ranging from 0 to 6 cm. The results are shown in Table I.

TABLE I: VALUES FOR r WHEN $d_i = 26$ CM.; $d_j = 32.5$ CM.; $d_k = 46.8$ CM.

$r = X_a - d_a$	$(\log C_a - \overline{\log C_b})^2$
0	0.13272
1	0.12544
2	0.11873
3	0.11264
4	0.10696
5	0.10160
6	0.09676

From Equation 4, X_a is determined, and it is then possible to estimate the radioactivity of the source from a conversion factor obtained in a mock-up. The total activity in a source, or in the thyroid gland, is

$$\text{Microcuries} = \frac{\overline{C_b}}{\overline{K_b}} \qquad (5)$$

where $\overline{C_b}$ is the average of the net counts per minute at the three distances X_i, etc., and $\overline{K_b}$ is the average net count per min-

TABLE II: RELATIONSHIP BETWEEN THE DISTANCE FROM THE CENTER OF RADIATION TO THE SKIN, r, AND THE COUNTS PER MINUTE PER MICROCURIE, CORRECTED FOR ABSORPTION

r, cm.	$\overline{K_b} \times 64$
0	0.988
1	0.902
2	0.823
3	0.755
4	0.707
5	0.636
6	0.578

ute per microcurie at these distances as determined in the mock-up.

The influence of r on $\overline{K_b}$, corrected for absorption by tissue, is shown in Table II. Since the distance between the radiation center and the surface of the neck can be determined, the decrease in intensity of radiation due to absorption is given by

$$I = I_0 e^{-\mu r} \qquad (6)$$

The linear gamma ray absorption coefficient, μ, of tissue for I^{131} is 0.03 cm.$^{-1}$ (8). It is apparent that anatomical variations may lead to variations in observed net c/m per μc as great as 20 per cent due to absorption. The true values for $\overline{K_b}$ in Table II were obtained by applying this correction for absorption.

It is of interest to note that this method for the determination of the exact distance between the counter and center of radiation of the gland was developed independently in our laboratory at the same time that Myant, Honour, and Pochin (4) were doing their work. The method of calculation is similar except that we have used only three points for the inverse-square plot while Myant's group uses six points.

BACK-SCATTER

The scattering of gamma rays by matter results in an increase of the apparent net counts per minute per microcurie under the geometrical conditions that exist when radioiodine is used to study thyroid function. The problem of the correction for back-scatter can be treated in two ways: by the use of absorbers and by an empirical correction. Since scattered gamma rays are less energetic than the primary radiation, sufficient lead may be used to absorb

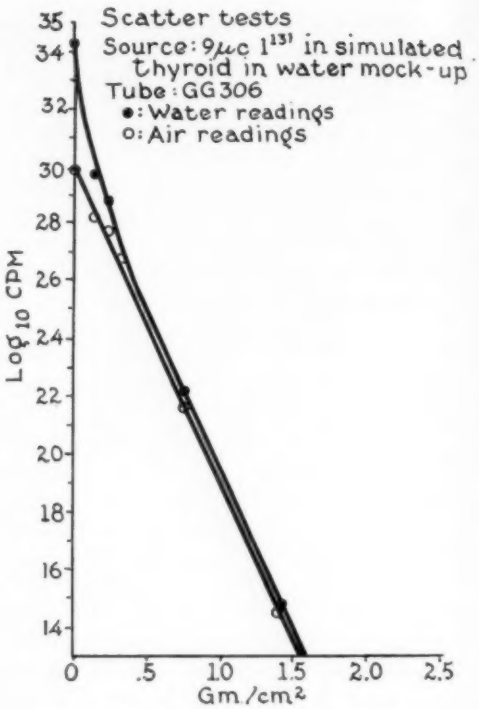

Fig. 1. Back-scatter tests.

them effectively so that the contribution of back-scatter to the net c/m per μc is insignificant. This is the method that we have used. The amount of lead required for this purpose was determined as follows: A water phantom was prepared using a 25-ml. volumetric flask containing 9 μc NaI^{131} which was immersed in water in a 1,000-ml. beaker. The flask was placed so that the distance between its vertical axis and the front of the beaker was 3.0 cm. The net c/m per μc were determined for various thicknesses of lead. Similar counts were made using the same flask suspended in free air. The true net c/m per μc in air was approximately 86 per cent of the apparent net c/m per μc for the same source in the water phantom. The results of the study are plotted in Figure 1, which shows that 1.5 gm./cm.^{2} of lead effectively eliminated the back-scatter.[2]

[2] In the Radioisotope Unit, Cushing V. A. Hospital, a similar study was performed, and it was found that 1.53 gm./cm.^{2} of lead was required to absorb the scatter. (Personal communication, Dr. Joseph L. Ross.)

The empirical correction for back-scatter used by Myant, Honour, and Pochin (4) was determined in intact human subjects. A small amount of I^{131} in a rubber tube was swallowed to the level of the thyroid gland. The net c/m per μc at this location was found to be 27 per cent greater than when the counting was done in free air. On the basis of these measurements, a correction factor of 0.785 is applied by these workers to all measurements of radioactivity in the thyroid. Since the esophagus is more centrally located in the neck than the radiation center of the thyroid, the difference between our value of 86 per cent and that of Myant *et al.* of 78.5 per cent is a reasonable one. It is our opinion that the use of a lead absorber is the preferred method for treating back-scatter. It is important to emphasize, however, that the error which results from disregarding it is considerable.

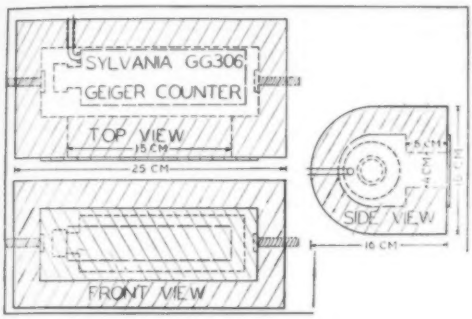

Fig. 2. Lead shield for Geiger-Müller counter.

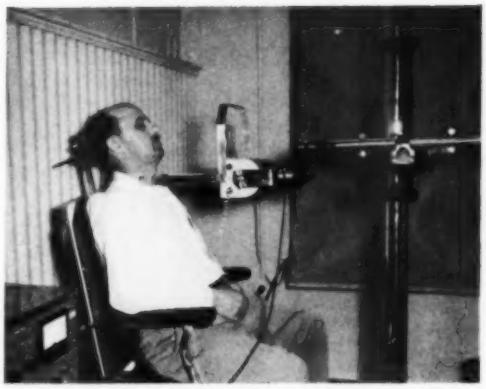

Fig. 3. Clinical set-up for determination of radioiodine in the thyroid gland.

BACKGROUND

When tracer doses of the order of 50 μc are used, the body background at twenty-four hours is insignificant for most patients, with the exception of those with hypothyroidism. At any time much less than twenty-four hours after administration of the tracer dose, body background should be taken into consideration. We have found (as have other workers) that it is entirely satisfactory to use the radioactivity of the thigh as the control for the measurement of the thyroid. The counting is done with the long axis of the GM counter parallel to the femur. The reading can be made at any of the spaced distances used over the thyroid. It is our practice to use the second position, $d_2 = 32.5$ cm., and to subtract the total c/m thigh from each of the three counts made over the thyroid. The result is net c/m thyroid.[3]

METHOD

A Sylvania GG-306 Geiger-Müller counter with a rated efficiency of 5 per cent for the gamma rays of I^{131} is mounted in a lead shield 2.5 cm. in thickness, a drawing of which is shown in Figure 2. The window in the shield measures 4 × 15 cm. and is covered with a lead absorber, 3 gm./cm.^{2} The shielded tube is mounted on a General Electric tripod base x-ray tube stand. The positioning of the tube with respect to the thyroid region is accomplished by two spacers (see Figs. 3 and 4). The tube-skin distance obtained with these spacers is 26.0 cm. and 32.5 cm., respectively. The third measurement is made at 46.8 cm., the distance being measured by a plastic rod 14.3 cm. in length. These

[3] It is possible to derive a mathematical formula from the above expressions, which will give the net c/m due to body background without taking a thigh reading. The ratio of the calculated background at any time less than twenty-four hours (usually at two to three hours) and the body background obtained from a measurement over the thigh was found to be 0.84:1 for forty consecutive patients. Since there is no advantage to the calculation of the background, the measurement over the thigh has been used.

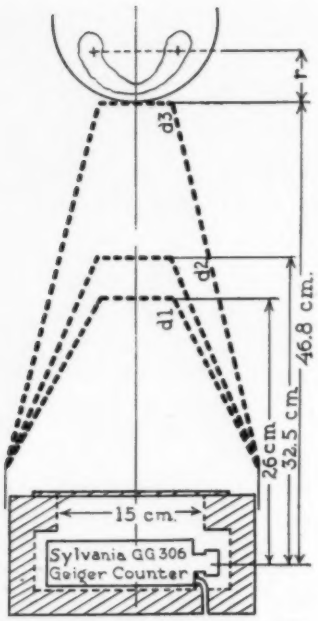

Fig. 4. Positioning of counter with respect to thyroid gland.

distances were chosen so that the ratio of the readings at 26 cm. and 46.8 cm. would be approximately 3:1 for a normally located gland (r equals 4 cm.), and the readings at 32.5 cm. and 46.8 cm. would be related as 2:1. This permits a rapid check on the accuracy of the counts.

The horizontal iso-sensitivity curve for the shielded tube is shown in Figure 5. It can be seen that the source can be moved almost 10 cm. in either direction laterally without affecting the c/m per μc. Figure 6 shows the vertical iso-sensitivity curve. Within a vertical distance of ± 2.5 cm., variations of the location of the source with respect to the horizontal plane of the tube are seen to have little influence on the c/m per μc. Movement greater than this results in a sharp decrease in the counting rate. It is apparent that this shielded tube "sees" 95 per cent of the activity in an area approximately 20×10 cm. at the distances at which it is used.

The determination of the uptake of I^{131} by the thyroid is made as follows: The tracer dose, 50 μc, is given orally to a fasting patient. With the patient sitting in a dental chair with a head support, the plane of the axis of the tube is aligned with the lower border of the thyroid cartilage by means of the spacer. Counts are made, using a scaler (scale of 64), for two minutes at each spaced distance, approximately two hours and twenty-four hours after administration of the dose. The body background is measured over the thigh at 32.5 cm., also for two minutes. The entire procedure takes less than ten minutes. The counting data are recorded on a work

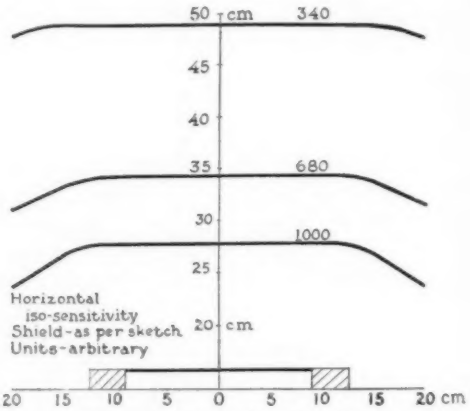

Fig. 5. Horizontal iso-sensitivity.

sheet, along with a calibration count of a recently assayed flask of I^{131}. A sample of the work sheet and of the calculations is shown in Figure 7. The calculation of total microcuries in the gland requires the use of a logarithm table and is no more complicated than the usual computation of a basal metabolic rate. The method of calculation is explained in the legend to Figure 7.

The time of the readings, two hours and twenty-four hours, was chosen for the following reasons:

(1) They are convenient in terms of hospital routine.

(2) In euthyroid patients the uptake curve has become asymptotic by twenty-four hours and tends to remain so for about twelve hours more.

(3) In hyperthyroid patients an increased rate of uptake is generally evident

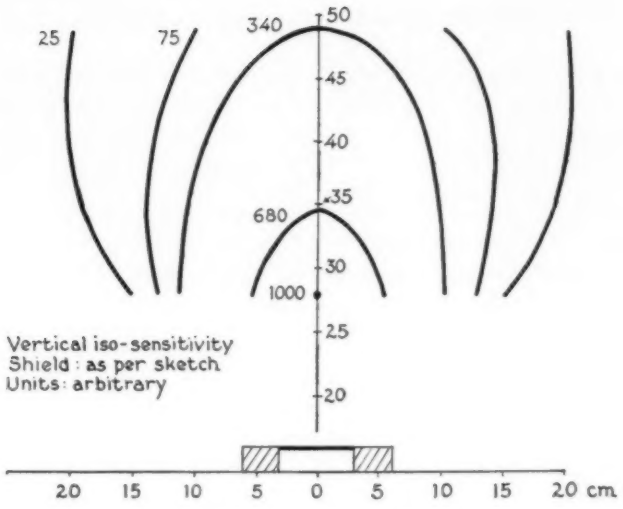

Fig. 6. Vertical iso-sensitivity.

Patient: C. L. Age: 32 Female Date: 3/29/50

Dose: 50 microcuries, orally

24 Hours Data

		C_i 26 cm	C_j 32.5 cm	C_k 46.8 cm	
A.	Net 2 minute count*	20	14.6	7	all x 64
B.	Net C/M	10	7.3	3.5	all x 64
C.	Log_{10} of B	1.000	.863	.544	
D.	Average Log		.802		
E.	C - D	.198	.061	.258	
F.	$(C - D)^2$	.039	.0037	.066	
G.	ΣF		.108		
H.	r in cm		4		
J.	Average of B		6.9		
L.	$J/\overline{K_b}$		9.76 μc in gland at 24 hours		
M.	L x 1.1		10.7 μc, corrected for decay to t_o		

Fig. 7. Work sheet for calculation of amount of I^{131} in the thyroid: counting data.

A. Net 2-minute count is the reading of the scaler (×64) minus the room or the thigh background.
B. Net c/m, for C_i, etc., of Equation 2.
C. Logarithm to base 10 of the net c/m at each distance, C_i, etc.
D. The average of the logarithms of C_i, C_j, etc.; this is the expression $\overline{\log C_b}$ in Equation 3.
E. $(\text{Log } C_a - \overline{\log C_b})$ for each value of C in line C.
F. $(\text{Log } C_a - \overline{\log C_b})^2$, as in Equation 3.
G. $\Sigma (\text{Log } C_a - \overline{\log C_b})^2$, the summation of the values in line F, see Equation 3.
H. The value, r: the distance from the radiation center to the anterior surface of the neck, from Table I for the corresponding value of $\Sigma(\text{log } C_a - \overline{\log C_b})^2$.
J. $\overline{C_b}$, the average of net c/m at each distance, C_i, etc., see line B.
L. Total μc at time, t is given by $\mu c = \overline{C_b}/\overline{K_b}$; $\overline{C_b}$ is from line J; and $\overline{K_b}$ is from Table II for the proper value of r, from line H.
M. Correction to zero time; for I^{131}, use 1.1 per day.

at two hours, and in our experience the asymptotic portion of the curve persists to twenty-four hours.

(4) In hypothyroid patients in whom the diagnosis is well established, the reading at twenty-four hours is never more than twice that at two hours, and in the majority of cases there is little difference between the two readings.

amount of I^{131} was put in the neck. The value found on analysis is listed in the table as the amount injected. The results of this study are shown in Table III. Earlier in our experience with radioiodine measurement, we attempted to calibrate counters by use of this method with cadavers. The estimates of the total microcuries varied from the actual amount

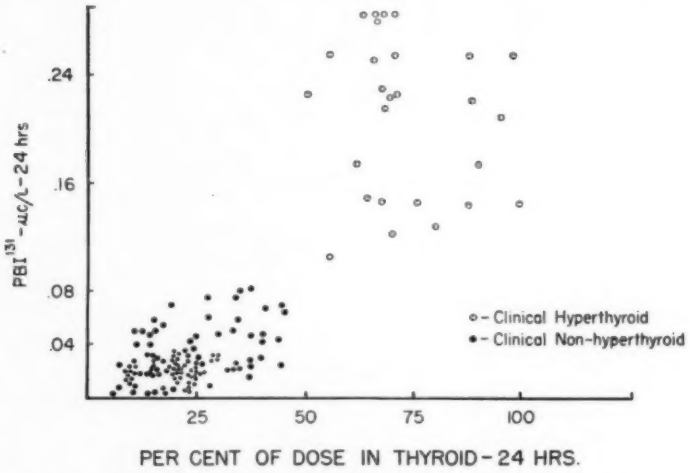

Fig. 8. Per cent of dose in thyroid at twenty-four hours in clinically hyperthyroid and non-hyperthyroid subjects.

RESULTS

The following studies were conducted to test the reliability of the calibrated counter and the method of calculation of the percentage of dose in the thyroid gland at twenty-four hours.

Cadaver Studies: The thyroid gland was exposed without removing the muscles of the neck. Solution of NaI^{131} was injected into each lobe and the strap muscles and the skin were replaced. Estimation of the radioiodine content of the gland was done in exactly the same manner as described for tracer tests. After the external measurements were made, the entire gland was removed and submitted to radioassay. In the third cadaver, after the measurement was made, the thyroid gland was removed and a plastic model of a thyroid containing approximately the same

by as much as a factor of 2. It was this observation that led us to develop the present method, which would correct for back-scatter, absorption, and variations of the geometry of the gland. With a tracer dose of 50 μc, the average per cent of dose in the gland at twenty-four hours in euthyroid subjects is 21 ± 8 per cent. With the apparatus described, 10 μc (see Fig. 7) in the gland yields approximately 450 counts per minute (net). For a two-minute counting period the standard error of counting is ±3.3 per cent. When the thyroid contains as little as 1.0 μc or less, the standard error of counting becomes ±10 per cent, and we do not attempt to calculate the actual content, but express it as < 1 μc. The fact that these cadaver experiments demonstrated that we could "recover" 100 ± 10 per cent of the dose

TABLE III: ESTIMATION OF I^{131} INJECTED INTO THYROID GLAND OF CADAVERS

Number of Cadaver	Amount Injected (μc)	Amount Found (μc)	Per Cent Recovered
1	13.2	14.7	111
	26.4	22.8	86
	39.6	41.5	105
2	5.5	4.8	87
	11.0	11.5	104
3	26.6	27.2	102
	24.4*	26.7	109
		Mean recovery:	100.6 ± 10.1

* This amount of I^{131} was placed in a plastic model of a thyroid gland which was substituted for the gland removed from the cadaver.

injected into the gland was considered very gratifying.

Clinical Studies: A satisfactory method of testing the accuracy of the shielded counter would be to estimate the I^{131} content of the gland just before total thyroidectomy. The entire gland could then be submitted to radioassay and the results compared. This has not been possible in our hospital to date. A good estimate of the accuracy of the measurements in intact patients can be obtained by preparing a balance sheet for the findings at twenty-four hours after a tracer, using patients with typical hyperthyroidism with diffuse goiter. This type of patient is the most suitable, since at that time the majority of the tracer dose is either in the thyroid gland or is in a protein-bound form in the plasma. Variations of the inorganic iodide^{131} space are of relatively little significance in such patients at twenty-four hours. Typical balance sheets for 16 patients with untreated hyperthyroidism are shown in Table IV. The actual measured urinary output of I^{131}, plus the measured amount in the gland, plus an estimated 2.0 μc for the total circulating protein-bound I^{131}, should equal the tracer dose. Variable losses which cannot be measured readily are due to radioiodine excretion in sweat, gastrointestinal secretions, etc. Balances in excess of 100 per cent are probably due to the fact that back-scatter is not completely eliminated by the absorber used. It can

TABLE IV: BALANCE SHEET FOR I^{131} AFTER ORAL TRACER DOSE OF 50 μc IN PATIENTS WITH HYPERTHYROIDISM

Patient	Percent of Dose*		Per Cent Recovered
	In Thyroid	In Urine + 2 μc in Plasma	
Mc	76	14	90
Tn	82	7	89
Ri	69	8	77
Ky	69	36	105
Kw	75	25	100
Dr	68	24	92
Js	86	6	92
Fl	72	12	84
Sa	77	10	87
Le	98	10	108
Ad	71	9	80
Ne	88	16	104
Ko	69	16	85
Th	89	18	107
Kn	80	8	88
Ja	88	16	104
	Mean and standard deviation:		93.2 ± 10.3%

* Corrected for decay to zero time.

be seen from the table that it was possible, on the average, to account for 93 ± 10 per cent of the tracer dose.

Results of Tracer Tests Performed Routinely: This method for the external gamma ray measurement of the per cent of dose of radioiodine in the thyroid gland has been used routinely during the past year, over 300 measurements having been made in 170 patients. The classification of these patients as hyperthyroid, euthyroid, and hypothyroid has been made on the basis of a composite of the clinical examination, the basal metabolism tests, and the radioiodine study. The per cent of dose in the thyroid at twenty-four hours in each of the three clinical states is shown in Table V. In the construction of this table only equivocal cases[4] were excluded, and the evaluation of the thyroid state was made without reference to the external measurement of the per cent of dose in the gland. That is, it was based on the per cent excreted in the urine, the protein-bound I^{131}, the fraction protein-bound/plasma I^{131}, the basal metabolic rate,

[4] "Equivocal cases" to a large extent include patients who had received therapy with I^{131}, who had had subtotal thyroidectomy, or who had carcinoma of the thyroid. Patients under successful treatment with antithyroid drugs were also excluded from the tabulation.

TABLE V: RESULTS OF TRACER TESTS

Classification	Number	Per Cent of Dose in Thyroid	
		Mean	Standard deviation*
Hyperthyroid	19	73	±13
Euthyroid	105	21	± 8
Hypothyroid	9	3	± 3

* S.D. = $\sqrt{d^2/(n-1)}$

the serum cholesterol, and the clinical state. The values in Table V are in good agreement with those reported by other workers, but they display somewhat less overlapping between the euthyroids and the hyperthyroids than is usually reported.

The correlation between the estimated per cent of dose in the thyroid gland at twenty-four hours and the protein-bound I^{131} content of the plasma twenty-four hours after a tracer dose of 50 μc orally is shown in Figure 8. When equivocal cases are excluded from consideration, there is excellent correlation between these two principal methods of assessing the function of the thyroid gland.

DISCUSSION

In the development of a method for external measurement of radioiodine in the thyroid gland, our objective has been to devise a technic which is as easy to perform as a determination of the basal metabolic rate, and which has a high degree of accuracy. Our own studies and those of Myant, Honour, and Pochin (4) demonstrate that it is desirable to determine the exact position of the radiation center of the thyroid gland with respect to the GM counter. The inverse-square plot technic is a simple solution to the problem of locating a point source, such as the radioiodine containing thyroid, in space. The use of three positions at which counts are made is simpler than the use of six, and the results appear to be equally reliable. The solution to this problem suggested by Freedberg and his group (6) is technically much more difficult, since it requires the use of four GM counters with a high degree of similarity of response. Since each counter receives radiation from a point-source placed at a different distance, absorption and back-scatter can be additive and can be sources of error.

A trained technician can operate the measuring system that we have described. The type GG-306 Geiger-Müller counter tube is reliable and has a long useful life. The shield that we use was constructed of galvanized iron and filled with lead by the sheet-metal workers of the hospital. The other components were fabricated in the orthopedic brace shop. The computations may appear difficult at first, but actually they are simple operations performed with logarithms and small whole numbers. They should not offer any more difficulty than the usual calculations encountered in metabolism or clinical laboratories. Since the method of measurement is an absolute one, the radioiodine which is given as a tracer dose must be submitted to a careful radioassay. The calibration of the counter to determine $\overline{K_h}$, using a water phantom, need not be repeated frequently so long as response to a known amount of I^{131} in a flask in free air remains constant. All of these considerations are important, since taken together they make it possible to perform radioiodine tracer tests as a routine clinical laboratory procedure with a high degree of accuracy. We now believe that it may be preferable to administer the I^{131} intravenously to assure 100 per cent absorption and a definite zero time for measurements of rates of uptake and clearance and rate of formation of thyroid hormone. Regardless of the route of administration, it appears that this measurement method will permit accurate estimates of the fraction of the dose in the gland at a given time.

It is convenient to state that the studies in cadavers and the balance studies in hyperthyroid patients indicate that the measurement system described may be in error by approximately ±10 per cent or less. The possible sources of error in any measurement of radioactivity have been noted and it has been demonstrated that it is possible to minimize most of them by

appropriate technical methods and attention to detail. By using less lead absorber, larger net counts per minute per microcurie can be obtained with a corresponding reduction in the standard error of counting. However, this would result in an increase of back-scatter. The counting error can be reduced by counting for longer than two minutes, but this is not feasible in our laboratory because of the number of patients to be tested. With the present system we find it inconvenient to study more than six patients a day, three days a week.

SUMMARY AND CONCLUSIONS

(1) A method, approaching 100 per cent reliability, has been described for direct external measurement of the amount of radioiodine in the thyroid gland after a tracer dose. With this method the per cent of dose in the gland at twenty-four hours is found to be 21 ± 8 per cent for euthyroid subjects, 73 ± 13 per cent for hyperthyroids, and 3 ± 3 per cent for hypothyroids.

(2) Using an inverse-square plot the exact geometry of the thyroid gland can be determined, and corrections made for absorption.

(3) Back-scatter is effectively eliminated by a lead absorber of 1.5 gm./cm.^{2} or thicker.

(4) The radioactivity of the thigh can be used to estimate the body background, or it can be ignored at twenty-four hours in all subjects except hypothyroids.

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SUMARIO

Método Exacto para la Medición del Radioyodo en el Tiroides con un Contador Externo

El método descrito, dotado de una exactitud casi de 100 por ciento, permite la medición externa directa del radioyodo presente en el tiroides después de una dosis despistadora. El porcentaje de la dosis presente en la glándula a las 24 horas resultó ser 21 ± 8 por ciento en los eutiroideos, 73 ± 13 por ciento en los hipertiroideos y 3 ± 3 por ciento en los hipotiroideos.

El método requiere la determinación de la geometría exacta de la glándula por medio de un plano cuadrado invertido, rectificaciones con respecto a la absorción y eliminación de la retrodispersión con un absorbente plúmbico de 1.5 gramos/cm^2 o más de grueso.

Los datos se inscriben en una planilla, junto con una numeración de la calibración de un balón recién valorado de I^{131}, y los cálculos se hacen con una tabla logarítmica.

Puede usarse la radioactividad del muslo para estimar la del cuerpo o puede desatenderse a las veinticuatro horas, excepto en los hipotiroideos.

The Scintillation Counter as an Instrument for In Vivo Determination of Thyroid Weight[1]

HERBERT C. ALLEN, JR., M.D.[2] and WILLIAM E. GOODWIN, M.D.

THE SCINTILLATION counter—a new name in the rapidly expanding nomenclature of medical science—has been used by other branches of science for only a short time, although the principle was employed by Rutherford and his coworkers at an early stage of their fundamental investigations. It is being applied by physicists to the detection and measurement of cosmic rays, and of alpha particles and beta particles. Now, for the first time, scintillation counting is being developed for the detection and measurement of gamma radiation in an application designed principally for use in clinical medicine. The *gamma* scintillation counter serves essentially the same function in medicine as the more familiar Geiger-Müller tube or counter, namely, the detection of gamma radiation. Just as the Geiger-Müller counter gets its name from the Geiger-Müller tube employed in its construction, so the scintillation counter gets its name from a property of the synthetic crystal or luminescent phosphor that enters into its construction. These luminescent phosphors, when exposed to different types of radiation, give off visible light and are thus said to scintillate. The phenomenon is a familiar one in medical science, for it is this that makes possible the fluoroscopic examination of patients. X-rays from the hot cathode tube strike the calcium tungstate or cadmium tungstate coating of intensifying screens or the zinc-cadmium coating of a fluoroscopic screen, and visible light is given off. In the scintillation counter, the same phenomenon occurs but it is applied in a somewhat different manner.

As a detector of gamma radiation, the scintillation counter has many advantages over the conventional Geiger-Müller counter in clinical medicine. It is many times more sensitive to gamma radiation, depending on the phosphor used. The calcium tungstate scintillation counter now in use at Wadsworth Veterans Administration Hospital is over one hundred times as sensitive as the end-window (3.5 mg./sq. cm.) Geiger-Müller tube. By virtue of this increased sensitivity to gamma radiation, it has become possible, in the study of thyroid function with radioiodine, to lower the tracer dose of 8-day I^{131} to harmless levels, such that the thyroid gland is exposed to no more radiation than is received by the skin from a routine survey chest x-ray examination and only one-twenty-eighth that from a routine gastrointestinal series. A second advantage offered by the increased sensitivity of the scintillation counter is that, with specially designed equipment, it is now possible to determine the weight of the thyroid gland *in vivo*, which is essential for the proper calculation of the dose of radioiodine to be used in the treatment of thyrotoxicosis.

A scintillation type of radiaton detector consists of a luminescent phosphor capable of transforming an appreciable fraction of the incident particle of radiation energy into luminescent light, a photomultiplier tube for converting this light into electrical pulses, and the necessary electronic equipment to record these pulses in a suitable manner.

The first practical arrangement for the detection of ionizing radiation by scintillation counters was described in 1947 by

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[1] From the Radioisotope Laboratory and Department of Medicine and Surgery, Wadsworth General Hospital, Veterans Administration Center, Los Angeles, Calif. Presented before the Thirty-sixth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 10–15, 1950.

Reviewed in the Veterans Administration and published with the approval of the Chief Medical Director. The statements and conclusions of the authors are the result of their own study and do not necessarily reflect the opinion or policy of the Veterans Administration.

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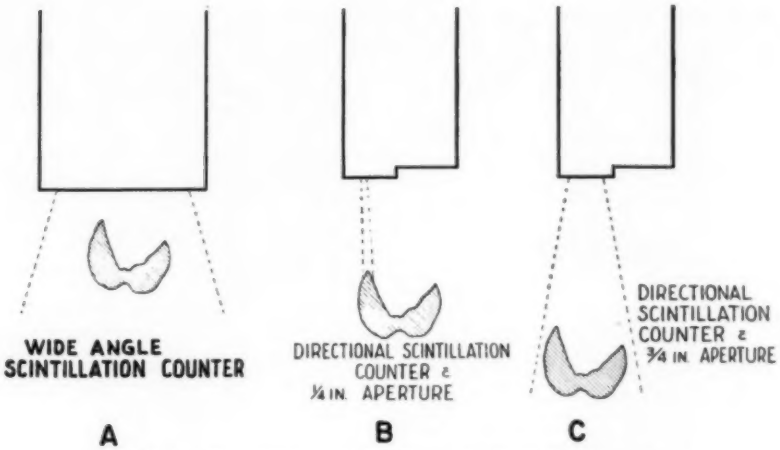

Fig. 1. Functional use of two types of scintillation counter.

Broser and Kallmann (1, 2) and by Coltman and Marshall (3). Recently, Cassen, Reed, and Curtis (4) have developed a scintillation counter for detection of gamma radiation which was designed principally for use in clinical medicine. For the past eight months in our laboratory and clinic we have used the scintillation counters designed by these latter scientists, which utilize both the 1P21 and 5819 photomultiplier tube with calcium tungstate as the scintillating phosphor.

Many other types of scintillating phosphors (5) are possible, employed either with a double or triple coincidence circuit (6) or in a multivibrator circuit such as is being used at present in our laboratory. Many theoretical advantages are offered by the double and triple coincidence circuits and by other types of inorganic, organic, plastic, and liquid phosphors (6) and it is only through further research that the ideal universal phosphor and circuit combination will be found. In our investigation of scintillation counting, however, the single-gate circuit in conjunction with calcium tungstate has proved so satisfactory in our experience that we have felt it unnecessary to complicate our clinical measurements by introducing coincidence circuitry. Time alone will tell whether appreciable gains can be obtained with other arrangements. With such a multivibrator circuit, a noise or tube background of 3 to 4 counts per second (180 to 240 counts per minute) is obtained when the instrument is performing at 66 per cent efficiency.

INSTRUMENTATION

Two types of scintillation counter have been developed, each for a different clinical application but both employing the same fundamental principles of scintillation counting and both utilizing a multivibrator circuit with the calcium tungstate crystal as the scintillation phosphor. The "wide-angle" scintillation counter (Fig. 1A), so-called because of the wide arc it subtends, is employed for determining the percentage of administered radioiodine concentrated by the thyroid gland. The entire gland can be covered when the tube is placed several centimeters from the neck. The second type of counter (Fig. 1, B and C) has been designated the "directional" scintillation counter (4) because of the high spatial resolving power obtained by virtue of its crystal arrangement and construction and because of the different-sized apertures that can be used with the instrument. Figure 1B demonstrates the use of the "directional" scintillation counter for outlining or mapping the thyroid gland. The "directional" counter is a more versatile instrument than its counterpart, the

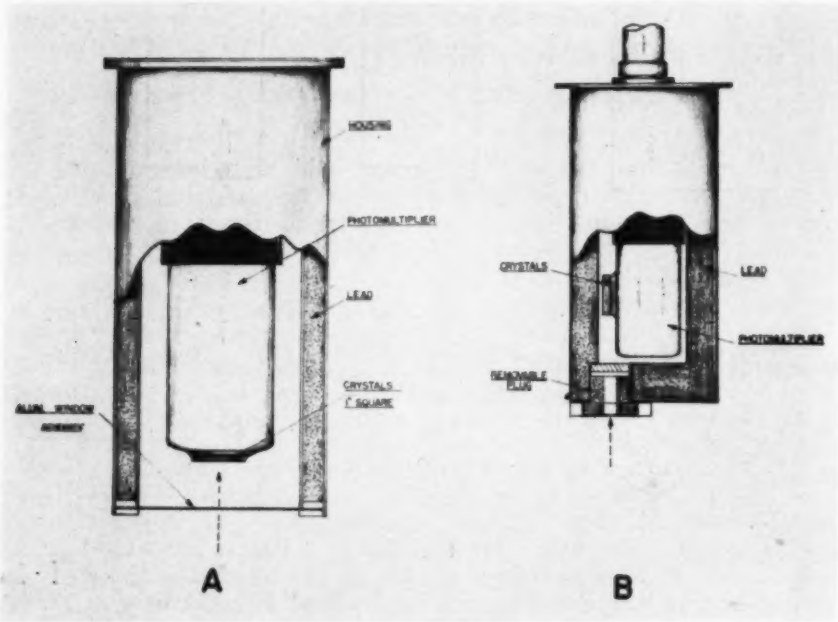

Fig. 2. Schematic drawing of "wide-angle" scintillation counter (A) and "directional" scintillation counter (B).

"wide-angle" counter (Fig. 1A). Merely by changing the aperture to 3/4 inch and moving the counter farther away from the neck of the patient, it can be used for determining the ability of the thyroid gland to concentrate iodine. This dual use, however, has involved some sacrifice of sensitivity, and larger doses of I^{131} are required for tracer studies by this means than with the "wide-angle" scintillation counter.

Figure 2A demonstrates schematically the construction of the "wide-angle" scintillation counter with its 1-square-inch calcium tungstate crystal assembly mounted on the end of the photomultiplier tube, which is encased in a lead housing. The incident gamma ray is indicated as entering from below. As shown by the diagram of the "directional" scintillation counter (Fig. 2B), the principal differences in its construction are the location of the scintillating crystals on the side of the tube rather than the end, the number of crystals, and the type and size of the photomultiplier tube. Actual photographs of the 5819 phototube used in the "wide-angle" scintillation counter and the 1P21 phototube (7) used in the "directional" counter are reproduced in Figure 3.

THE MICROCURIE DOSE OF I^{131} FOR STUDY OF THYROID FUNCTION

Because of the greatly increased sensitivity of the "wide-angle" scintillation counter over the conventional end-window Geiger-Müller counter for the detection of gamma radiation, it has become possible to lower the tracer dose of I^{131} required for routine diagnostic thyroid surveys and still obtain reliable counting rates and data. According to the literature (8–11), the doses of I^{131} currently being used in the majority of clinics throughout the country range between 50 and 250 microcuries of 8-day radioiodine. With the scintillation counter, it has now become possible to use 1 microcurie of I^{131} as a tracer dose in the study of thyroid function (12). Even smaller doses are possible, though the need for them has not as yet presented itself.

The "wide-angle" scintillation counter

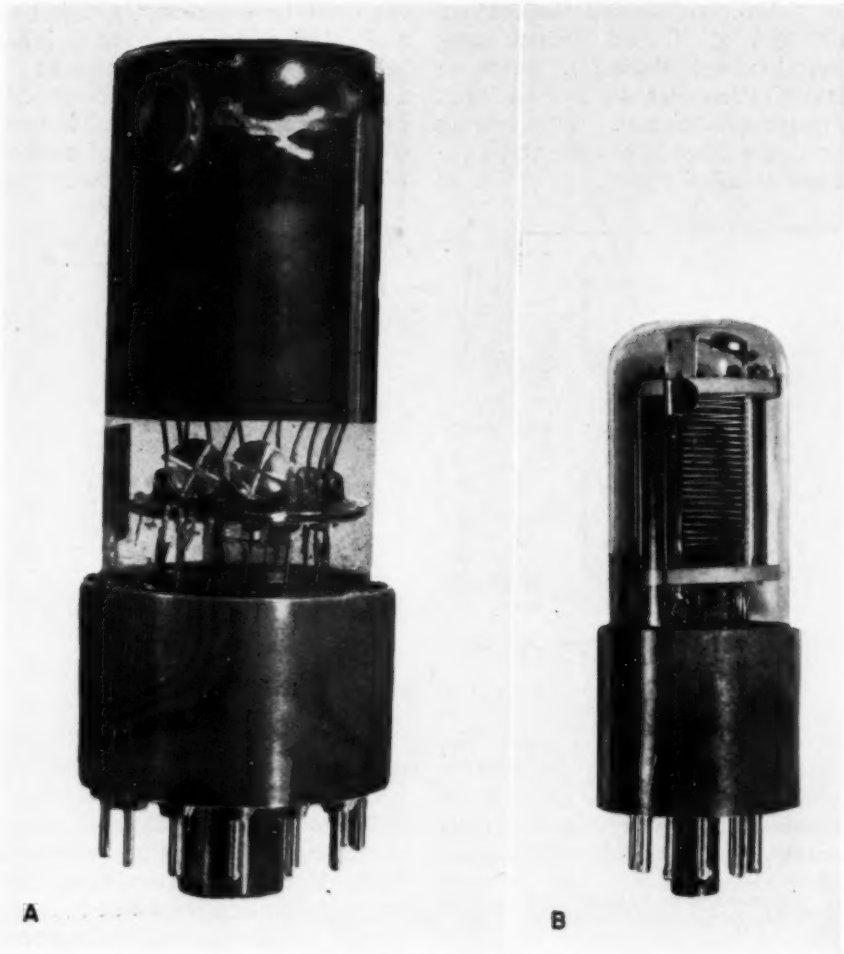

Fig. 3. Photomultiplier tubes used in "wide-angle" scintillation counter (A) and in "directional" scintillation counter (B).

is over 100 times as sensitive as the end-window Geiger-Müller counter, while the "directional" scintillation counter is 35 times as sensitive, on an area-for-area basis. With the former, 1 microcurie of I^{131} gives 130 counts per second (c/s) or 7,800 counts per minute (c/m) at 6 cm. distance when the noise background is 3.6 c/s or 216 c/m, as compared with 1.3 c/s for the Geiger-Müller counter (Table I). More recently, under more proper operative conditions (1,100 volts, with a noise background of 12–14 c/s), the "wide-angle" scintillation counter was found to be 150 times more sensitive than the end-window Geiger-Müller counter.

TABLE I: COMPARISON OF COUNTING RATES OF ONE (1) MICROCURIE OF I^{131}

Distance	"Wide-Angle" Scintillation Counter (C/S)	End-Window Geiger-Müller Tube (C/S)
6 cm.	130.1	1.3
12 cm.	35.1	0.4
24 cm.	9.5	0.1

Approximately 38.4 per cent of the incident quanta give countable scintillations

when the "wide-angle" scintillation counter with a 1 × 1 × 1/8-inch calcium tungstate crystal is used (Table II). More recent investigation has shown an even greater quantum efficiency. By increasing the operating voltage to a more stable region of the so-called "plateau," it can be demonstrated that 56.8 per cent of the incident quanta give countable scintillations.

TABLE II: COUNTING EFFICIENCY OF CALCIUM TUNGSTATE "WIDE-ANGLE" SCINTILLATION COUNTER

No. quanta emitted by 1 microcurie of I^{131} through 1 sq. in. crystal, at 24 cm.	31.9
No. counts actually recorded by "wide-angle" scintillation counter	12.5*
Per cent incident quanta giving countable scintillations	38.4

* Uncorrected for absorption.

DETERMINATION OF THYROID WEIGHT AND THE OUTLINING OF THYROID ADENOMATA

The "directional" scintillation counter is used primarily at the Wadsworth Veterans Administration Hospital for outlining or mapping the thyroid gland in thyrotoxicosis. It has been used, also, for total uptake studies, in which case a larger dose than one microcurie of I^{131} is required. By the use of the counter as an outlining instrument, it is possible to determine the completeness of a total thyroidectomy, and, in the event residual thyroid tissue is found, it has been helpful in directing the surgeon to the involved region. In several cases of thyroid carcinoma, it has been possible to demonstrate paratracheal areas of radioactivity following a total thyroidectomy (Fig. 4C).

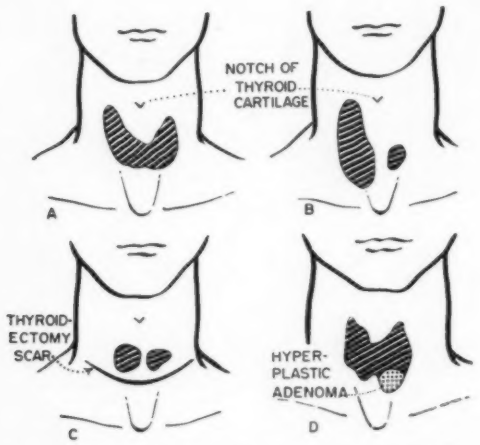

Fig. 4. Clinical applications of the "directional" scintillation counter. A. Asymmetrical lobes in diffuse hyperthyroidism. B. Recurrent hyperthyroidism. C. "Total" thyroidectomy for carcinoma of thyroid. D. Non-toxic hyperplastic adenoma.

Whether or not these areas represented accessory thyroid tissue, residual normal thyroid tissue, or functioning metastatic thyroid tissue, is not known. The "directional" scintillation counter has been found to be useful in determining the extent of a subtotal thyroidectomy when no surgical records were available. This latter application is helpful in the proper interpretation of radioiodine uptake studies in patients with recurrent hyperthyroidism following previous subtotal thyroidectomy (Fig. 4B). Figure 4A illustrates asymmetrical lobes of the thyroid found in a case of diffuse hyperthyroidism. On several occasions it has been possible to demonstrate the presence of the pyramidal lobe, which was otherwise not discernible. Figure 4D shows a hyperplastic adenoma or nodule hidden within the substance of the thyroid gland, which had been detected and outlined preoperatively. Figure 5 is the

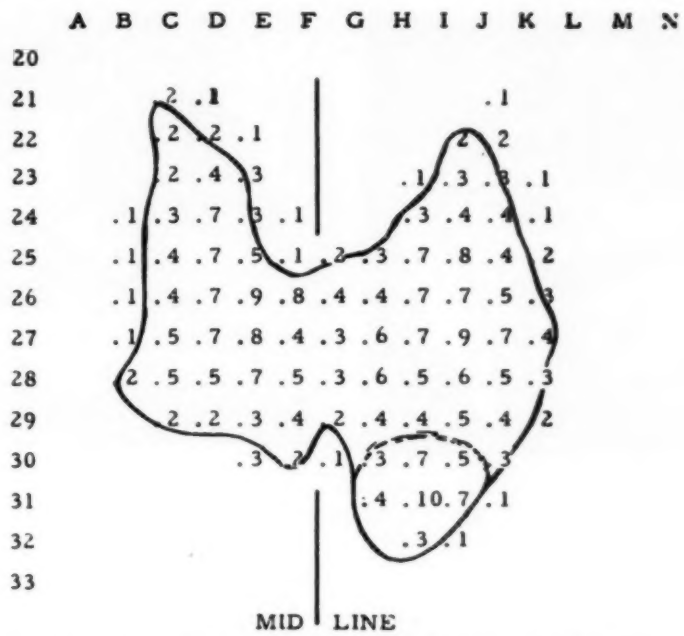

Fig. 5. Non-toxic hyperplastic adenoma (see Fig. 4D). Figures represent counts per second. Note increased number of counts in left lower pole.

actual working diagram of the drawing shown in Figure 4D. This silhouette demonstrates the usefulness of the "directional" scintillation counter in localizing unsuspected areas of greater activity than the surrounding thyroid tissue. In the left lower pole an area is shown in which the counts per second are higher than the counts in the centermost part of the gland. Preoperatively, it was thought that this represented a hyperactive nodule and this was confirmed postoperatively both by gross and microscopic inspection and by radioautographs of the nodule and surrounding tissue.

The most important use of the "directional" scintillation counter at the present time, however, is for outlining the thyroid gland in thyrotoxicosis, as a means of determining thyroid weight. The determination of thyroid weight, as is well known, is of paramount importance in the calculation of the dose of radioiodine to be used in the treatment of this disease. The accurate determination of the correct dose is essential before radioiodine therapy can be properly evaluated in the treatment of thyrotoxicosis.

The importance, in dosage calculation, of determining the amount of radioactive iodine concentrated by the thyroid gland and the effective half-life (13) need not be discussed here. Both are fairly well standardized procedures and both are essential for accurate dosage calculation. The determination of the size and weight of the gland, however, has not met with the same success, and is far more difficult. It is the inaccurate estimation of weight that introduces the greatest errors in dosage calculation and that is largely responsible for the poor clinical response that frequently occurs as a result of treatment with inadequate amounts of radioiodine. Up to now (12), there have been no accurate methods of determining thyroid size (14) other than manual palpation of the gland, with the fingers used as calipers. Palpation, combined with clinical experience, was then utilized to estimate the weight of the gland. Obviously, this method is open to considerable error. Soley (15) and his colleagues,

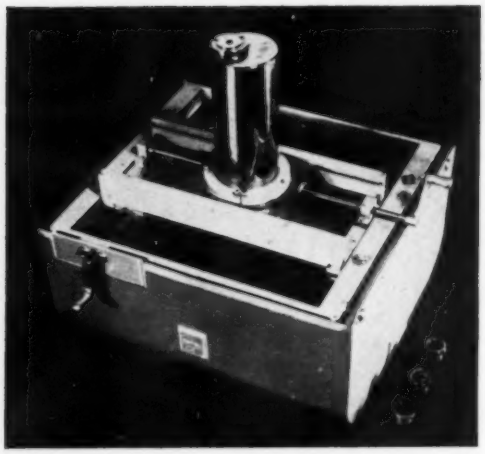

Fig. 6. The "directional" scintillation counter is easily mounted on the movable stage of the manual scanner (inverted in picture). The mechanism of the manual scanner is very similar to that of the mechanical stage of the microscope, in that micromovements can be made in perpendicular directions in the same plane with great precision. The two-directional movement of the scintillation tube is controlled by means of the two cranks visible in the photograph. (Note selection of different-sized apertures.) An electric motor has been mounted inside the housing (not shown in photograph). When it is used in conjunction with an X-Y recorder or a specially designed heat-writing stylus that makes a variable density tracing on heat-sensitive paper similar to that used in modern EKG records, mapping of the thyroid can be done as a routine procedure.

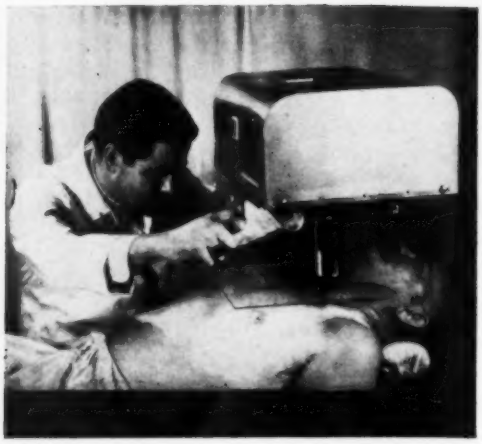

Fig. 7. Patient in a dental chair in supine position, with skin of anterior surface of neck horizontal. The transparent lucite co-ordinate grid is placed several millimeters above the skin, resting on the sternum and thyroid cartilage. The "directional" scintillation counter with 1/4-inch aperture is mounted on the manual scanner. The manual scanner functions very similarly to the mechanical stage of the microscope for controlling precise movements of the scintillation tube. The tube is moved back and forth along the grid lines by means of two cranks and the activity is determined at each intersection of co-ordinates. Approximately one hour is required for mapping in this manner.

who for twelve years had been estimating thyroid size in patients prior to thyroidectomies, have shown that in 74 cases studied they were able to come within 10 per cent of the actual weight in only a fourth of the number.

Because it is now felt that the weight of the thyroid gland can be determined reasonably accurately, it is no longer our practice to give a standard dose of radioiodine to every patient with hyperthyroidism, to be followed later by a second dose should the initial dose be inadequate. Instead, each dose is individualized. Up to the present time the initial dose has ranged between 2.5 millicuries and 16 millicuries of I^{131} in order that 7,000 equivalent roentgens may be delivered to the thyroid gland.

The hyperthyroid patient whose gland is to be outlined receives between 75 and 100 microcuries of carrier-free I^{131} intravenously, in normal saline. Forty-eight to

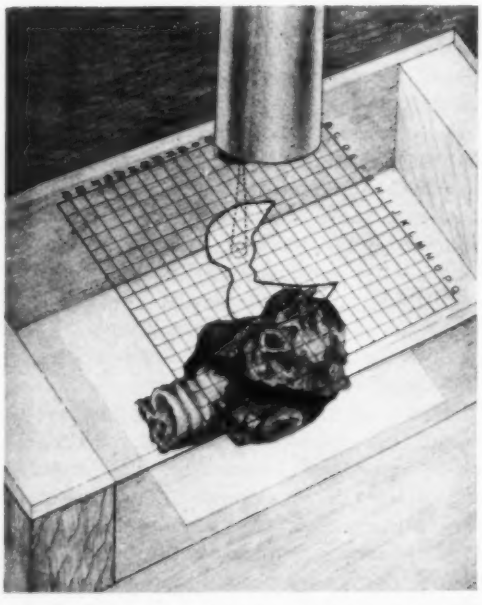

Fig. 8. Outlining of radioactive thyroid gland *in vitro*. The "directional" scintillation counter is centered over each of the intersections of the co-ordinates and counts are automatically recorded on a recording milliammeter.

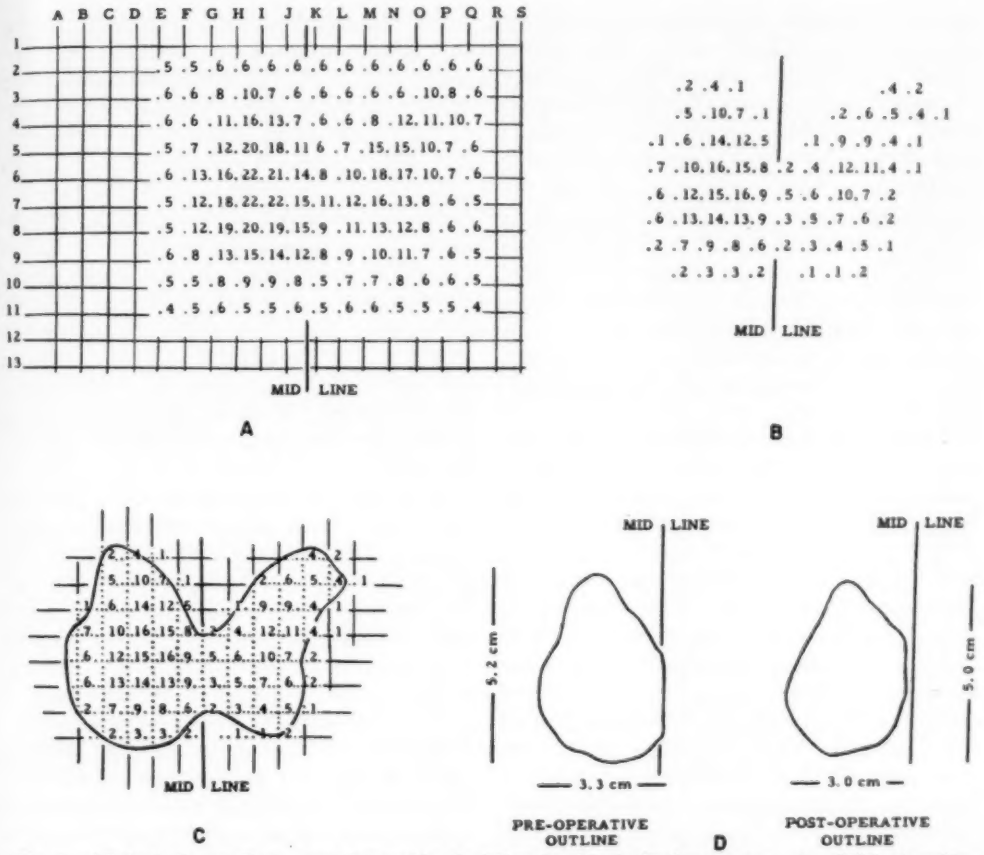

Fig. 9. Method of recording counts detected by the "directional" scintillation counter. A. Original working diagram. B. Frontal silhouette, with neck background subtracted. C. Two counts per second was felt to represent the border of the gland. A line is drawn joining all these points. D. Comparison of preoperative outline of the right lobe with actual outline determined following a right hemithyroidectomy.

seventy-two hours later he returns and is placed in the supine position in a dental chair. To facilitate mapping of the thyroid gland, a mechanical stage for attachment to the x-ray arm was constructed in the Radioisotope Laboratory with micromovements in two directions but in only one plane. This attachment, called a manual scanner (Fig. 6), functions in a manner very similar to the mechanical stage of the microscope and has been routinely used for the past three months in the Radioisotope Clinic. At the present time there is under construction a motor-driven attachment for the scanner which, when used in conjunction with a recorder, will function in somewhat the same fashion as the ink-writing device of the electrocardiograph and thus make possible the outlining of the thyroid gland in a minimum of time.

The "directional" scintillation counter and manual scanner are mounted on the adjustable arm of a portable x-ray stand from which the x-ray tube and control panel have been removed (Fig. 7). The patient's head is slightly hyperextended, so that the skin of the neck is horizontal. A transparent lucite drawing board cut to conform to the contour of the structures of the submental region is placed horizontally over the neck, resting on the sternum and thyroid cartilage. The thyroid gland is outlined by using a system of rectangular coordinates from which the frontal and

lateral silhouettes are obtained, as shown diagrammatically in Figure 8. The "directional" scintillation counter is placed one or two millimeters above the lucite drawing board, on which is mounted a cellophane grid of horizontal and vertical rectangular coordinates. The counter mounted on the manual scanner is moved back and forth in a horizontal plane over each of the horizontal grid lines by means of two cranks, and readings are taken at each intersection of the horizontal and vertical lines. The counts are automatically recorded by the count rate meter and a recording milliammeter.

After the survey is completed, the counts are transcribed from the recording milliammeter to the cellophane grid (Fig. 9A). The counts at the periphery of the graph usually represent neck background and are due to the radioiodine present in the skin, subcutaneous tissue, and other adjacent structures. The average of these counts, six counts per second in the case illustrated, is subtracted from each of the points recorded. Figure 9B demonstrates the silhouette thus obtained. After further study of this silhouette, an estimate is made as to the counts per second most likely to represent the edge of the thyroid gland. A line is then drawn connecting all such points (Fig. 9C). In the instance illustrated it was felt that two counts per second represented the border of the thyroid gland. The preoperative silhouette of the right lobe thus obtained was found to be in close agreement with the measurements of the lobe following a right hemithyroidectomy (Fig. 9D). The right and left lateral silhouettes of the thyroid can be obtained in essentially the same manner as the frontal silhouette. Sometimes, however, it is difficult to obtain a lateral silhouette because of the restlessness of thyrotoxic patients even with proper sedation. In such cases the weight of the gland can be determined from the frontal silhouette alone, and the area of the thyroid gland represented by the frontal silhouette is then determined. Calculations *may* be less accurate when done in this manner.

For the determining of the weight of the thyroid gland from the frontal silhouette alone, a formula was developed based upon the assumption that in diffuse hyperthyroidism there is an isometric or symmetrical enlargement in all directions due to generalized hyperplasia, and that any increase in the depth of the gland is proportional to an increase in its height. Based upon this assumption, it became evident, from necropsy material and surgical specimens, that the ratio of the weight of the gland to a product of the area of the frontal silhouette and the height of the gland is more nearly a constant, K, ranging between 0.125 and 0.152, with an average of 0.128.

When the area of the frontal silhouette, expressed as the total number of $^1/_4$-inch squares, is multiplied by the height of the gland or lobe expressed in centimeters and the result is multiplied by the factor 0.128, the weight of the gland or lobe can then be calculated according to the following formula: *weight of gland or lobe in grams = area of frontal silhouette of gland or lobe (expressed in* $^1/_4$*-inch squares) × height of gland or lobe (in centimeters) × K. (i.e., 0.128).* If a planimeter reading in square centimeters is used to determine the area of the frontal silhouette, the K factor used in the formula becomes 0.323. When the calculated weight is compared with the actual weight, as determined immediately postoperatively or at necropsy, the two closely agree (Table III). In the 10 cases outlined thus far in which surgical or necropsy proof has been possible, there has been no discrepancy greater than 25 per cent, the average being ±10 per cent. These cases cover a great variation in size and weight of the thyroid gland, ranging from 10.5 to 125 grams.

For the sake of expediency and because of its simplicity, the above method has been used as a means of determining thyroid weight, so essential a step in proper dosage calculation for the treatment of diffuse hyperthyroidism. It is felt, however, that use of both frontal and lateral silhouettes of the gland promises the most

TABLE III: SURGICAL AND NECROPSY PROOF OF ACCURACY OF FACTOR AND WEIGHT FORMULA

Patient	Average Factor	Surface Area, Frontal Plane (sq. cm.)	Gland Length (cm.)	Calculated Weight (gm.)	Actual Weight (gm.)	Per Cent Variation	Factor for Each Gland
G *	0.323	25.6	7.8	64.5	63.9	− 0.9	0.320
D *	0.323	17.4	6.0	33.7	26.9	+25.4	0.257
S *	0.323	16.1	6.5	33.8	32.6	− 3.7	0.312
E *	0.323	7.8	4.3	10.8	12.0	−10.1	0.358
C *	0.323	6.4	4.5	9.3	10.0	− 7.0	0.348
B *	0.323	40.7	9.5	124.9	132.5	− 5.7	0.343
M*	0.323	15.0	5.2	25.2	28.2	−10.5	0.361
A3†	0.323	6.8	4.5	9.9	10.7	− 7.1	0.348
A12†	0.323	10.9	8.0	28.2	31.5	−10.6	0.361
L*	0.323	14.6	6.5	30.7	27.1	−13.4	0.285
						Av. Error: ±10.6%	

* Proved surgical cases.
† Necropsy cases.

accurate method of determining thyroid weight, and further work is being done with this in mind. The application of this technic for determining thyroid weight in thyrotoxicosis has resulted in the administration of larger therapeutic doses, ranging as high as 16 millicuries of 8-day radioiodine for a single initial dose, without any increase in the incidence of post-therapeutic hypothyroidism.

It is our opinion that a "single dose" accurately calculated by this method will produce a better therapeutic response than repeated small doses. The technic of treating thyrotoxicosis with repeated small doses is probably the natural consequence of the inability to determine accurately the radioiodine dose, largely due to errors in the estimation of thyroid weight. This uncertainty in the dose determination has led the clinician to become over-conservative in the matter of dosage in an effort to avoid over-treatment. This in turn has resulted in a rather high incidence of persistent or recurrent hyperthyroidism, necessitating repeated or "multiple" doses to obtain a satisfactory therapeutic response.

The "single dose," accurately calculated, has other advantages over the "multiple dose" technic. It overcomes the objection of administering larger and larger doses of radioiodine with each succeeding treatment in order that the same amount of radiation may be received by the thyroid tissue. With "multiple dose" therapy, repeated exposures of thyroid tissue to radiation may result in increased resistance to radiation, and larger doses may prove necessary to bring about a therapeutic response. The "single dose" form of therapy does not have this disadvantage, which results in a greater exposure to radiation of extrathyroid tissue. This fact, in addition to what is felt to be a better therapeutic response, has brought us to the conclusion that the "single dose," accurately calculated, is an improvement in the treatment of thyrotoxicosis and should be given an adequate trial.

SUMMARY

1. A technic is described for the precise outlining of the thyroid gland and of hyperplastic and hypoplastic adenoma within the thyroid parenchyma, by use of a scintillation counter and tracer doses of I^{131}.

2. A method is presented for the determination of thyroid weight so essential for the accurate calculation of the radioiodine dosage for use in treatment of thyrotoxicosis.

3. As a result of the increased efficiency of these scintillation counters, 1 microcurie of I^{131} can now be routinely administered as a diagnostic tracer in the study of thyroid function.

4. Two types of scintillation counters are described, the "directional" scintillation counter and the "wide-angle" scintillation counter, 150 times more sensitive than the Geiger-Müller tube.

5. The efficacy of the "single dose" treatment of thyrotoxicosis with radioiodine is discussed.

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SUMARIO

El Cuentachispas como Instrumento para la Determinación in Vivo del Peso del Tiroides

Descríbense dos tipos de escintilómetros para descubrir los rayos gamma. Esos contadores comprenden un fósforo luminiscente capaz de transformar una fracción apreciable de la energía radiante incidente en luz luminiscente, un tubo fotomultiplicador para convertir la luz en latidos eléctricos y la necesaria instalación electrónica para registrar dichos latidos.

El cuentachispas de "ángulo ancho" es de 100 a 150 veces más sensible a los rayos gamma que el tubo de ventanilla terminal de Geiger-Müller y permite ejecutar estudios de pesquisa hasta con 1 microcurie de radioyodo (I^{131}) de ocho días.

El escintilómetro "directivo" es empleado principalmente para bosquejar o demarcar el tiroides como medio de calcular el peso del mismo, lo cual es de importancia primordial para determinar la dosis de radioyodo que hay que usar en el tratamiento de la tirotoxicosis. Resulta posible así individualizar el tratamiento, evitar el tratamiento insuficiente, como ha sucedido frecuentemente debido a la incertidumbre que rodea a la determinación del peso en otras formas, y usar, en vez de la técnica de dosis múltiples, la de dosis única, que es más eficaz.

Con el uso del cuentachispas "directivo" como instrumento demarcador, también ha resultado posible determinar cuan completa ha sido una tiroidectomía "total" y la extensión de una tiroidectomía subtotal, cuando no hay a mano protocolos quirúrgicos.

DISCUSSION

Hymer L. Friedell, M.D. (Cleveland, Ohio): Dr. Allen has made a very valuable contribution, and his particular counter, utilizing calcium tungstate, is an excellent adaptation. His application of this counter to outlining the thyroid is an ingenious one and will be extremely useful. One of the problems that is encountered in the use of radioiodine for therapy is an estimation of the size of the thyroid for computing dosages. Up to now this has been done entirely by means of palpation, and at Western Reserve University we have reservations about the accuracy of our measurements. We have often facetiously remarked that before we attempt palpation of the thyroid gland our finger-tips should be "sandpapered."

A great deal of work is still to be done on scintillation counters of various types. There are a number of crystals that appear promising, each possessing various advantages. We have used anthracene because of its stability. As you have heard, calcium tungstate, which has a high efficiency, has been utilized by Dr. Allen. Another crystal which shows great promise is thallium-activated sodium iodide. I can add very little to Dr. Allen's beautiful presentation.

Innominate Artery: Angiocardiographic Study[1]

EDWARD I. HONIG, M.D., ISRAEL STEINBERG, M.D., and CHARLES T. DOTTER, M.D.

THE RADIOLOGIST is familiar with the problems involved in the differential diagnosis of roentgenographically demonstrated right superior mediastinal prominences. Similar shadows may represent a variety of neoplastic, infectious, granulomatous, vascular, and other lesions (Fig. 1). Aneurysm, dilatation, or buckling of the innominate artery may produce roentgenographic findings which simulate those of retrosternal thyroid enlargement, mediastinal lymph node enlargement, mediastinitis, or disease within the apex of the right lung. In the past it has occasionally been necessary to resort to exploratory thoracotomy in order to distinguish between innominate artery aneurysm and superior mediastinal tumor; this distinction may be made with ease through the use of angiocardiography (1). The present report summarizes our experience with contrast visualization as it bears upon the innominate artery.

NORMAL INNOMINATE ARTERY

The normal innominate artery is the largest branch of the arch of the aorta, having been found in postmortem studies to measure from 3.7 to 5.0 cm. in length. It arises as the first of the three great brachiocephalic arteries from the ascending portion of the aortic arch; its point of origin is approximately on a level with the upper border of the second right costal cartilage. It takes an oblique course upward, backward, and to the right, to the level of the upper border of the right sternoclavicular junction, where it bifurcates to form the right common carotid and subclavian arteries. Anteriorly, the innominate artery is related to the left innominate and right inferior thyroid veins and the right vagus nerve. Posterior to it is the trachea, which it crosses obliquely. To the right are the right innominate vein, the superior vena cava, the right phrenic nerve, and the pleura. To the left are the thymic remnant, the left common carotid artery, the inferior thyroid veins, and the trachea (2, 3).

The conventional postero-anterior chest roentgenogram does not reveal the normal innominate artery, since it does not project to the right of the spine and since the superior vena cava and the right innominate vein form the right superior mediastinal border in this projection. In the left anterior oblique projection, the innominate artery forms the anterior, superior portion of the cardiovascular silhouette, above the curve of the ascending aorta. Its posterior border is invisible. Elongation and dilatation of the artery may result in its becoming border-forming in the frontal projection (4).

Angiocardiographic findings are in conformity with the anatomical and roentgenographic descriptions given above (Fig. 2). Due to its relatively small caliber (in comparison to that of the aorta), the innominate artery is not invariably well demonstrated by angiocardiography. Serial studies are of special value in this connection. As is true of the aorta, the increased density caused by atherosclerosis and the increase in caliber associated with dilatation enhance contrast visualization of the innominate artery. Although extensive measurements were not carried out in this investigation, it was found that in 20 normal adult cases the width of the artery at a point midway between its origin and bifurcation ranged from 8 to 13 mm. and averaged 10 mm. In general, the vessel is probably dilated if its width exceeds 14 mm. A caliber of 20 mm. is not unusual

[1] From the Department of Radiology of The New York Hospital-Cornell Medical Center. This investigation was aided by grants from the New York Heart Association and the Schering Corporation. Accepted for publication in June 1951.

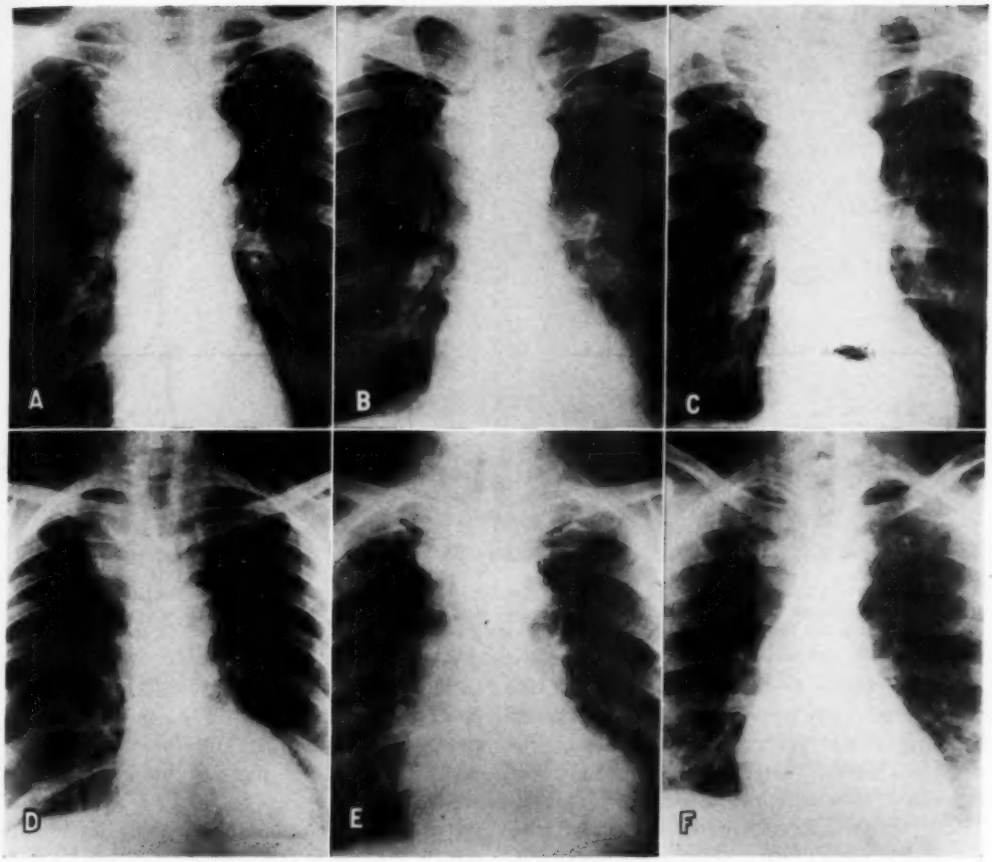

Fig. 1. Right superior mediastinal densities, similar in appearance but of varied etiology. A. Innominate artery aneurysm (angiocardiogram shown in Fig. 5). B. Bronchial cyst. C. Lymphoma. D. Retrosternal thyroid. E. Buckled innominate artery (tracing of angiocardiogram at lower left, Fig. 3). F. Right aortic arch and descending aorta with aortic diverticulum simulating normal left-sided aortic knob.

In A, E, and F, the lesions were accurately identified by angiocardiography, while vascular lesions were excluded in B, C, and D.

in the presence of syphilis or coarctation of the aorta.

ARTERIOSCLEROSIS AND HYPERTENSION THE BUCKLED INNOMINATE ARTERY

Elongation, tortuosity, and dilatation of the innominate artery usually are associated with arteriosclerotic and hypertensive involvement of the aortic arch. Hypertension produces unfolding and dilatation of the aorta, and when arteriosclerosis coexists, as usually occurs, there is concomitant lengthening (5, 6). The aortic arch thus becomes elevated, and buckling or kinking of the innominate artery may result. The nature of this tortuosity or buckling depends upon the degree and direction of displacement of the origin of the vessel and upon the amount of its elongation. Thus, while in certain instances a knuckle of elongated artery which has been doubled upon itself may project to either side ("buckling"), in other instances of arteriosclerosis, particularly when the origin of the vessel is displaced to the left, this may not occur. Figure 3 shows the (traced) angiocardiographic findings in six instances of arteriosclerotic and hypertensive elongation of the innominate artery.

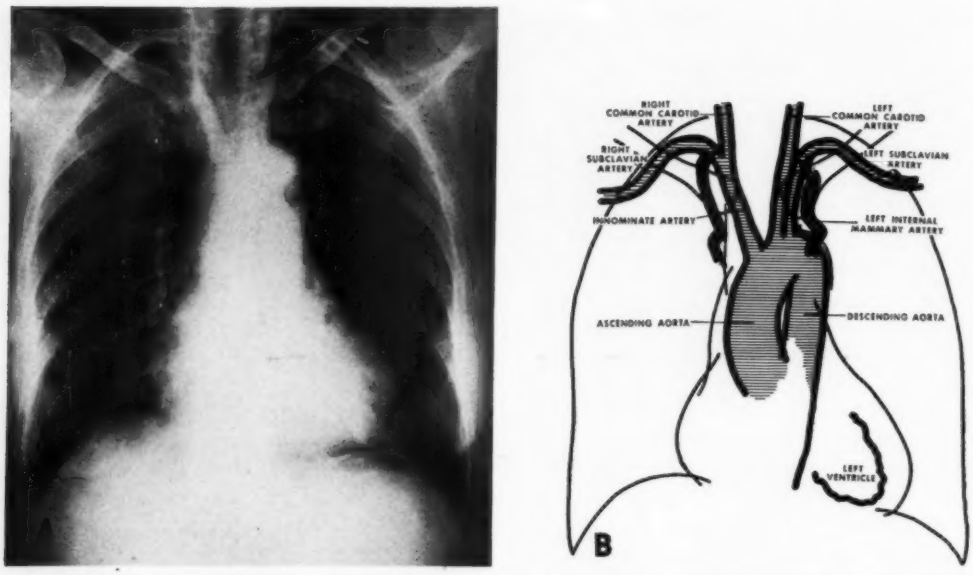

Fig. 2. Normal innominate artery, in a 46-year-old female. A. The normal anatomy of the innominate artery with its bifurcation into the right subclavian and right common carotid arteries is shown on frontal angiocardiogram made ten seconds after injection. B. Tracing of A, aorta and branches shaded.

The tortuous or buckled artery may become clinically apparent as a pulsating swelling at the right side of the base of the neck. This may suggest an innominate or carotid artery aneurysm. Balfour (7) in 1898 reported the case of a woman who noticed a throbbing swelling in her neck. At autopsy the innominate artery was found to be 2 inches long and twice its normal diameter. Stadler and Albracht (8) in 1911 attributed a swelling at the base of a patient's neck to sclerosis and dilatation of the innominate artery. Parkinson (6) studied 48 cases and reviewed the relevant literature. He concluded that such palpable pulsations were in most cases not due to aneurysm or localized arterial dilatation but were the result of tortuosity either of the right common carotid or innominate artery, or of both, together with a varying degree of dilatation of these arteries.

In the course of the present study, a review of 80 angiocardiograms of individuals with arteriosclerotic and/or hypertensive disease (but without evidence of syphilis) revealed 7 instances of buckling of the innominate artery. In an additional 6 cases, dilatation and elongation were present, although buckling was not apparent. The artery usually buckles to the right, but was seen to project toward the left in 2 of the 7 cases. Four patients had severe hypertension; in the remaining 3 the blood pressure was normal. Of the 6 patients with elongation and dilatation of the innominate artery but without buckling, 5 had hypertension; all showed arteriosclerotic changes of the aorta. The caliber of the artery, measured in 10 cases of arteriosclerosis and hypertension, averaged 14 mm.

Parkinson (6) stressed the fact that buckling of the innominate and carotid arteries occurred almost exclusively in females. In the present series, 5 patients were female and 2 were male. In several patients, prior to angiocardiography, buckling of the innominate artery was incorrectly ascribed to aneurysm of that artery or of the aorta, retrosternal thyroid, or a right superior mediastinal tumor. Tortuosity of the innominate artery is of no prognostic significance and does not give

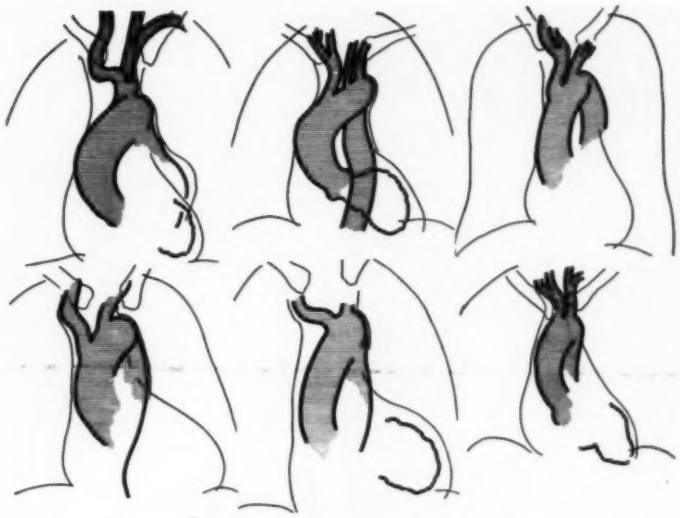

Fig. 3. Buckling of the innominate artery. Six tracings of angiocardiograms in frontal projection demonstrate buckling, tortuosity, elongation, and dilatation of the innominate artery associated with hypertensive or arteriosclerotic disease of the aorta.

rise to significant symptoms. Correct angiocardiographic diagnosis may eliminate needless operation by identifying such abnormal densities.

SYPHILIS OF THE INNOMINATE ARTERY

Syphilitic involvement of the innominate artery, in our experience, is invariably accompanied by aortic syphilis. This is in agreement with the observations of Warfield (9), who reported 20 cases of aneurysm of the innominate artery.

Innominate artery aneurysm is said to be uncommon. In a study of 530 aneurysms of various vessels, Crisp (10) found 20 of the innominate artery. Osler (11) reported the incidence as only about 3 per cent of all aneurysms. Though the lesion is uncommon, its recognition is important because of the difference from aortic aneurysm in the indications for surgery and in the type of surgical approach (12). Shumacker (13) states that direct surgical attack upon innominate artery aneurysms is necessarily largely limited to those cases in which the origin of the vessel is not involved. He feels that the procedure of choice ordinarily applicable is proximal and distal ligation combined with excision of the sac if possible. For those cases with involvement of the origin of the artery, wiring and coagulation, possibly combined with distal ligation, are probably the safest procedure offering the likelihood of a satisfactory result. The recent use of homologous blood-vessel grafts suggests a possible application to innominate artery aneurysm. It is to be recalled, however, that most innominate aneurysms are syphilitic in origin and that the proximal if not the distal suture line would of necessity have to be placed through diseased vessel.

For the purposes of this study, 141 cases of syphilitic aortitis were reviewed. Fifty-seven patients (39 per cent) had aneurysms of the aorta and/or the brachiocephalic arteries. Twelve (21 per cent) of these had innominate artery aneurysms. Six of the aneurysms were fusiform (Fig. 4), while 6 were saccular (Fig. 5). Three showed marked wall thickening due to the formation of laminated lining thrombi. Seven of the aneurysms arose directly from the site of origin of the innominate artery. Three arose close to the origin and 2 at or

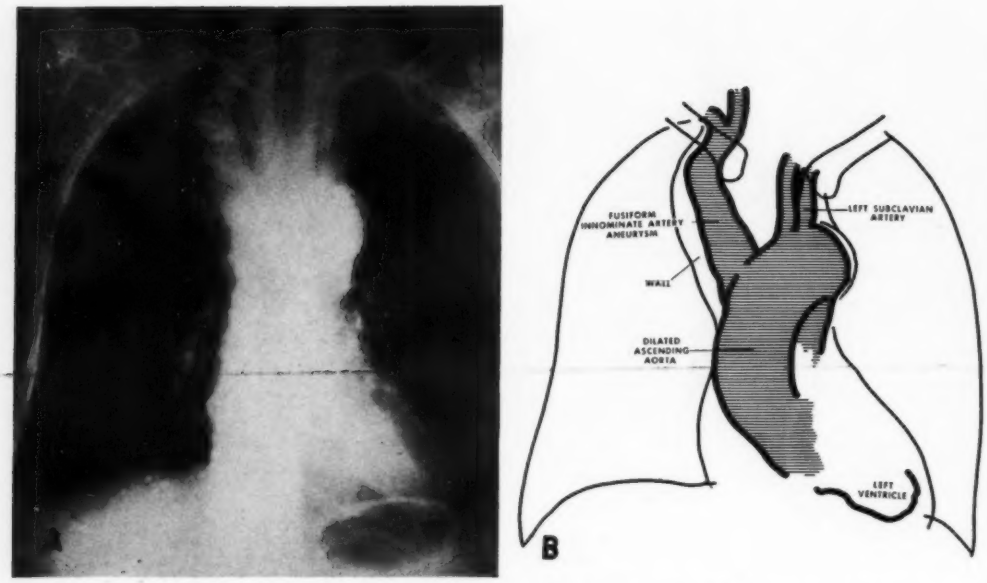

Fig. 4. Syphilitic aneurysm of the innominate artery in a 56-year-old male with dyspnea, cough, dizzy spells, weight loss, clubbing of the fingers of the right hand, and serologic evidence of syphilis. A. Frontal angiocardiogram at ten seconds. A huge fusiform aneurysm of the innominate artery with thickening of the vessel wall due to thrombus formation is visualized. B. Tracing of A, aorta and branches shaded.

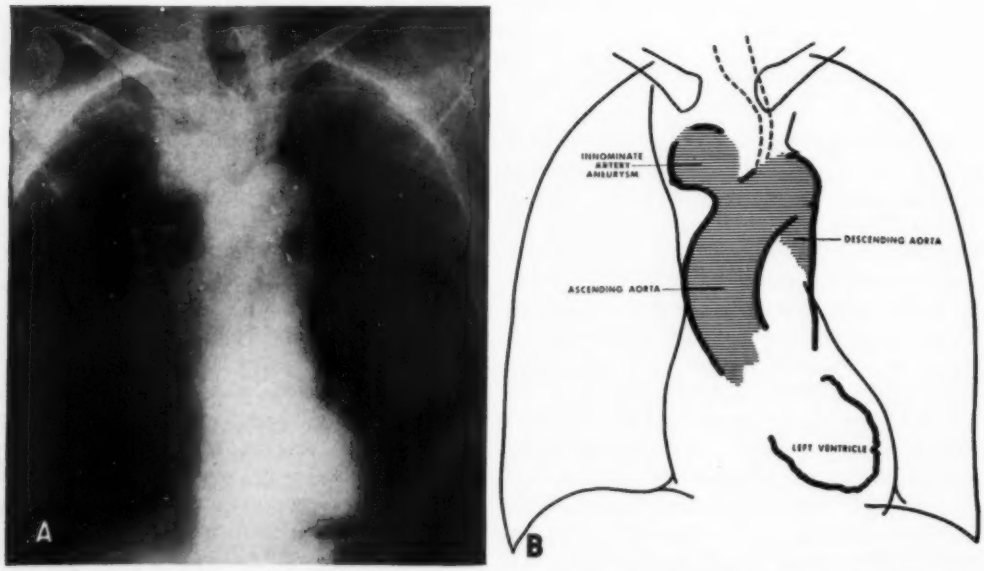

Fig. 5. Syphilitic aneurysm of the innominate artery in a 53-year-old male with syphilis diagnosed ten years earlier. A. A saccular aneurysm of the innominate artery is seen in the frontal angiocardiogram made at nine seconds. The aneurysm displaces the trachea to the left. B. Tracing of A, aorta and branches shaded.

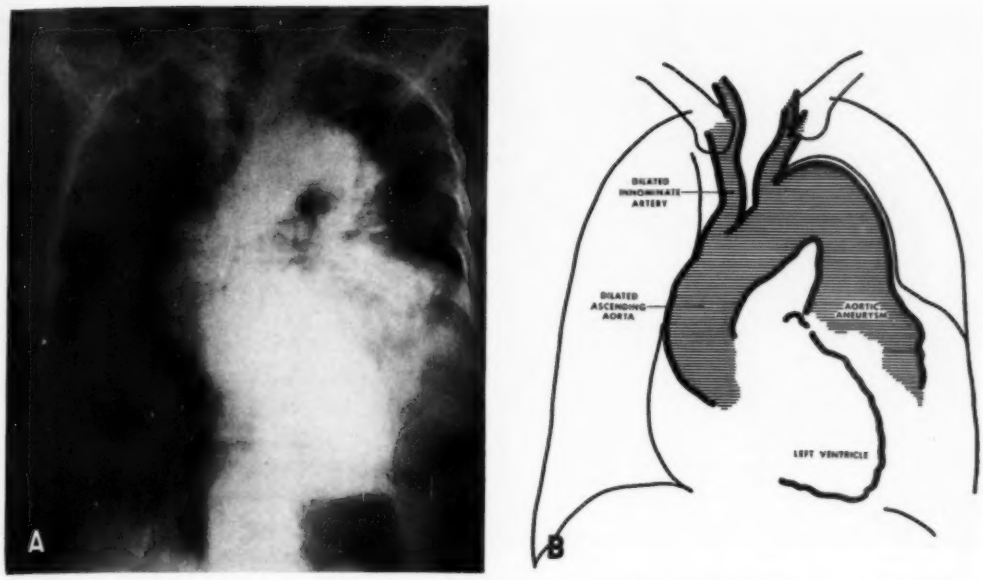

Fig. 6. Dilatation and tortuosity of the innominate artery and syphilis, in a 61-year-old male who also had syphilitic aortitis. A. Frontal angiocardiogram shows a dilated and tortuous innominate artery. There is also a fusiform aneurysm of the descending aorta. B. Tracing of A, aorta and branches shaded.

close to the bifurcation of the artery. In 2 instances there was displacement of the right innominate vein by the aneurysm and in 2 others the superior vena cava was displaced (14). Dilatation and tortuosity of the innominate artery (Fig. 6) are a frequent accompaniment of syphilitic aortitis. The caliber of the artery, measured in 10 cases of such dilatation, averaged 17 mm. The distinction between simple syphilitic dilatation and aneurysm of the innominate artery is more or less arbitrary and is based upon both size and shape. The term fusiform aneurysm might be reserved for those cases in which the maximal caliber of the artery exceeds 23 mm., laminated thrombus being included in the measurement. Saccular aneurysms offer no problems in nomenclature.

Among the more common complaints of the 12 patients with innominate artery aneurysms were dyspnea, dysphagia, hoarseness, cough, and weight loss. One patient had a right-sided Horner's syndrome. Another complained of pain in the right arm, which felt numb and cooler than the left arm. Several noted an abnormal swelling at the lower border of the right neck. Seven of the aneurysms were of sufficient size to impinge upon the trachea, although only 4 caused actual tracheal displacement. An esophagram was obtained in one patient and showed posterior deviation of the esophagus as a result of the aneurysm. Three cases showed unilateral clubbing, which was confined to the fingers of the right hand. Mendlowitz (15) cited 5 cases of unilateral clubbing associated with innominate artery aneurysm and stated that the most common causes of unilateral clubbing were aneurysms of the aortic arch, the innominate, and the subclavian arteries. The specific causal relationship is unknown.

Angiocardiography facilitates the differential diagnosis of innominate artery aneurysm, superior mediastinal tumor, retrosternal thyroid and aortic aneurysm. Adequate diagnosis is of course a prerequisite to treatment.

CONGENITAL ANOMALIES

Certain congenital abnormalities of the aortic arch may be accompanied by

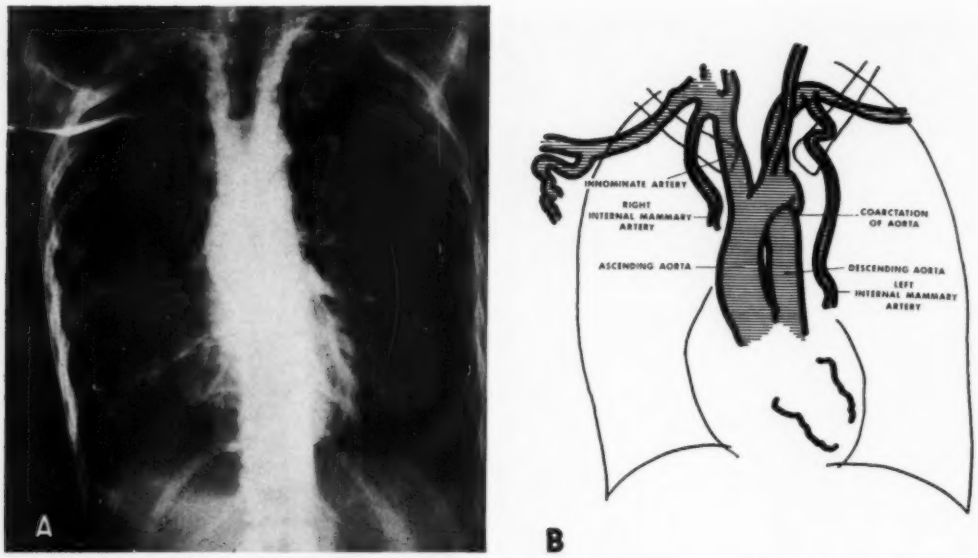

Fig. 7. Dilatation and tortuosity of the innominate artery with coarctation of the aorta in a 25-year-old female patient. A. Frontal angiocardiogram obtained at seven and a half seconds. Markedly dilated innominate and left subclavian arteries and a normal or slightly dilated left common carotid artery are seen. The internal mammary arteries are dilated and tortuous, demonstrating the collateral channels produced by the coarctation. B. Tracing of A.

anomalies of the innominate artery. The right subclavian and common carotid arteries may take independent origin from the aortic arch, the innominate artery being absent. Dextrocardia often is associated with a left-sided innominate artery. A common occurrence is a right subclavian artery originating distal to the point of origin of the left subclavian artery and passing to the right behind the esophagus (16). When such lesions give rise to symptoms of stridor or dysphagia, they can usually be identified by means of esophagrams and lipiodol studies of the trachea. Angiocardiography may be of value, although the findings are occasionally difficult to interpret.

It has been stated that in the presence of coarctation of the aorta the subclavian arteries are often distended and pulsate excessively, but the innominate and carotids are usually uninvolved (6). Reifenstein, Levine, and Gross (17) observed visible pulsation and sometimes tortuosity of vessels as a result of collateral dilatation in various areas including the supraclavicular and carotid. In one case of coarctation, this had given rise to a diagnosis of aneurysm of the innominate artery. Parkinson reported 3 cases of coarctation with an abnormal pulsation in the suprasternal notch which he thought was probably due to elevation and dilatation of the aortic arch with resultant high bifurcation of the innominate artery. Weber and Price (18) described a female patient with coarctation of the aorta who had a pulsating aneurysmal swelling in the right side of the neck, just above the clavicle.

Of 37 cases of coarctation of the aorta studied by means of angiocardiography, 11 showed dilatation and tortuosity of the innominate artery of varying degrees (Fig. 7). In only one of these was there clinical evidence of an abnormal visible pulsation in the right lower neck. Dilatation of the innominate and left subclavian arteries is frequently associated with coarctation of the aorta due to participation of these vessels in the collateral circulation. We have observed dilatation of the in-

nominate artery of up to 22 mm. in the presence of coarctation. If the collateral channels involved are considered, it is not surprising to note that dilatation of these two arteries is in excess of that of the left common carotid. Whereas many collateral channels arise from the innominate and left subclavian arteries (internal mammary, lateral thoracic and scapular channels), few arise from the left common carotid.

SUMMARY

An angiocardiographic study of the normal and abnormal innominate artery has been presented. Buckling of the innominate artery most commonly occurs with hypertension and arteriosclerosis. It may simulate retrosternal thyroid, innominate or carotid artery aneurysm, mediastinal infection, or neoplasm. Angiocardiography affords an accurate diagnosis in such situations and may eliminate exploratory surgery.

The early recognition of syphilitic innominate artery aneurysm and the demonstration of its anatomical point of origin are important in that both are of therapeutic significance. Angiocardiography facilitates the diagnosis, serving to differentiate the lesion from other conditions which produce right superior mediastinal widening on conventional roentgenograms. Innominate artery aneurysm was present in 12 of 57 patients with syphilitic aneurysm.

With coarctation of the aorta, the innominate artery as well as the left subclavian may be markedly dilated and tortuous.

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SUMARIO

El Tronco Braquiocefálico: Estudio Angiocardiográfico

Este estudio angiocardiográfico versa sobre la arteria anónima normal y anormal. El encorvamiento de la innominada ocurre más a menudo en presencia de hipertensión y arterioesclerosis, pudiendo simular tiroides retroesternal, aneurisma de la anónima o la carótida, infección mediastínica o neoplasia. La angiocardiografía aporta un diagnóstico exacto en tales situaciones y elimina la necesidad de exploración.

El reconocimiento temprano de un aneurisma sifilítico del tronco braquiocefálico

y el hallazgo de su punto anatómico de origen son importantes pues ambos poseen significación terapéutica. La angiocardiografía facilita el diagnóstico, sirviendo para diferenciar la lesión, de otros estados que producen, en las radiografías corrientes, dilatación de la región superior derecha del mediastino. En 12 de 57 enfermos con aneurisma sifilítico, éste radicaba en el tronco braquiocefálico.

Cuando existe coartación de la aorta, puede haber pronunciada dilatación y sinuosidad de la arteria anónima así como de la subclavia.

A New Method for Demonstrating an Aberrant Right Subclavian Artery[1]

ROBERT L. RAPHAEL, M.D., TRUMAN G. SCHNABEL, JR., M.D.,[2] and SIMON S. LEOPOLD, M.D.

THERE ARE NUMEROUS autopsy reports of aberrant right subclavian artery. The first authenticated case was observed postmortem in 1735 by Hunauld, and Bayford in 1794 designated the dysphagia that may result from such an anomaly as "dysphagia lusoria." Holzapfel, in 1899, recorded 133 instances discovered at autopsy (6). This is generally stated to be the most common of the congenital anomalies of the aortic arch (7), the incidence being given variously as 4 per thousand autopsies (9) to 12 per thousand (4).

The first report of an antemortem diagnosis of aberrant right subclavian artery was in the foreign literature; only in recent years have references to this anomaly appeared in the American literature. Copleman in 1945 described a case and was able to find only four reported cases up to that time in which the diagnosis was made during life (1, 3). Stauffer and Pote in 1946 (8) further stimulated interest in this anomaly, and Neuhauser in the same year (7) discussed it. Brean and Neuhauser in 1947 collected a series of cases associated with patent ductus arteriosus (2).

An anomalous right subclavian artery, in the majority of instances, is asymptomatic, though occasionally it may interfere with swallowing by pressing upon the esophagus. Symptoms may arise at any age, and in such cases it is possible to provide complete relief by severing the artery and removing it from behind the esophagus (5).

The authors referred to above and other investigators have adequately discussed the embryology and anatomy of an aberrant right subclavian artery (2, 8). The roentgenologic finding of an oblique extrinsic defect upon the barium-filled esophagus, usually just above the aortic knob, passing upward from left to right, has been clearly diagrammed and illustrated. The lesion is often seen best in the right anterior oblique position, but it is also evident in the postero-anterior projection as a defect on the left lateral aspect of the esophagus with a concavity to the left. Copleman points out that often the aberrant vessel arises from a diverticulum-like out-pouching on the adult aorta, and that this "diverticulum" may produce another lower and larger defect in the esophagus with a concavity to the right, resulting in a reverse "S" appearance.

The purpose of our report is to present a new method for demonstrating the course of an aberrant right subclavian artery when this is suspected during barium studies of the esophagus.

The right brachial artery is punctured with a No. 19 special thin-walled needle through which a radiopaque catheter, 70 cm. in length,[3] is inserted into the artery. Under fluoroscopic control, the catheter is advanced through the brachial and subclavian arteries into the descending portion of the aortic arch. Fluoroscopy and roentgenograms with the catheter in place, within the lumen of the vessel, demonstrate the actual course of the subclavian artery and its entrance into the aorta.

The following is a case report of a patient with an aberrant right subclavian artery confirmed during life by the foregoing method of investigation:

CASE REPORT

The patient was a white male, aged 33. In 1933,

[1] From the Departments of Radiology and Medicine, Hospital of the University of Pennsylvania. Accepted for publication in May 1951.

[2] This work was done during the tenure of a research fellowship of the American Heart Association.

[3] Specially developed by the Department of Physiology, School of Medicine, University of Pennsylvania. To be described in detail in another publication.

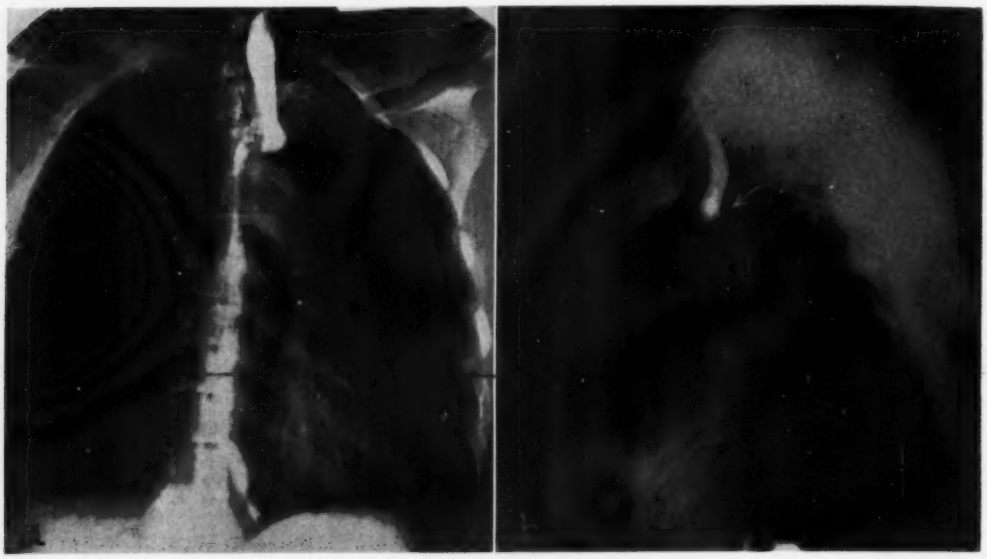


Fig. 1, a. Distortion of upper esophagus with concavity to the left due to an aberrant right subclavian artery.
b. Right lateral view demonstrating pressure on the posterior surface of the esophagus by the artery.

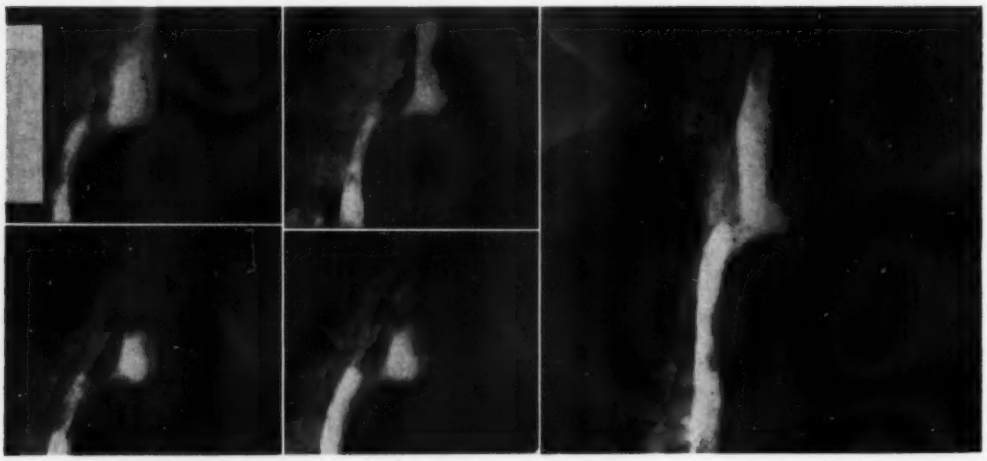
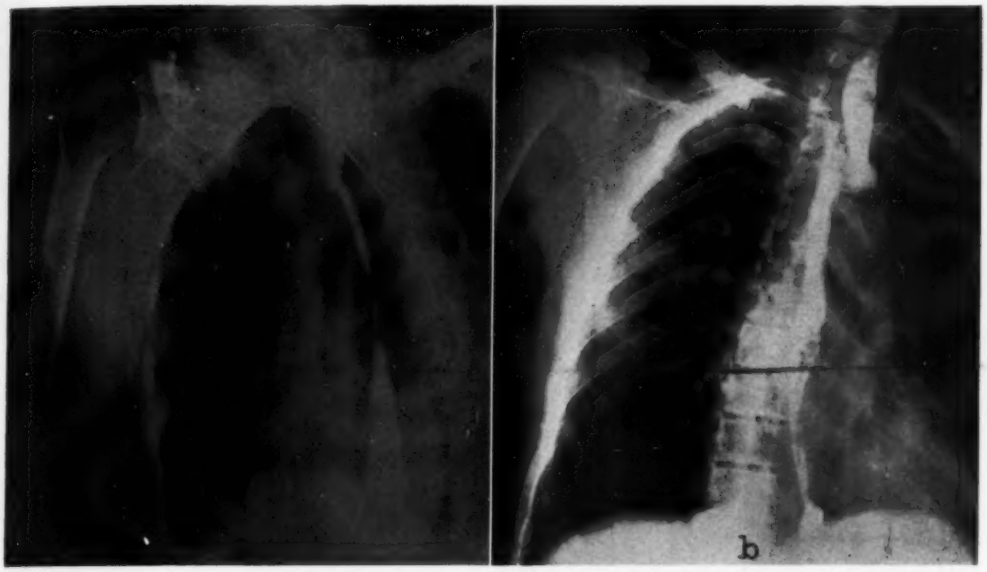


Fig. 2. Oblique views of the esophagus revealing partial posterior compression and anterior bulge simulating a diverticulum.

at the age of 16, he had an attack of substernal pain which awakened him from sleep. In the following two years he experienced numerous episodes described as indigestion. He had a left spontaneous pneumothorax in 1936; this recurred repeatedly, and in 1944 the patient was first seen by one of the authors (S.S.L.) during the sixth attack. In 1947 he had a recurrence of high substernal pain, and in January 1950, severe pain developed at the root of the neck, lasting several hours. No dysphagia was noted at any time. Laboratory studies revealed nothing of significance.

Roentgenologic examinations of the esophagus, at the Hospital of the University of Pennsylvania in 1944, 1947, and in January 1950, were interpreted as indicating an unusual diverticulum in the upper esophagus. At the last of these examinations the possibility of an aberrant vessel was suggested by Dr. Stephen Yohalem. Further roentgenologic investigation, independent of the preceding history,



was also interpreted as revealing an esophageal defect due to a vascular variant.

The roentgenograms showed the barium-filled esophagus deviating slightly to the left to the level of the apex of the aortic arch, there curving sharply posteriorly and to the right, passing almost horizontally for approximately 3 cm., and then dipping downward, resuming its normal course throughout the rest of its length (Fig. 1). The horizontal limb was obliquely compressed by a smooth object, later demonstrated to be a right subclavian artery of anomalous origin. Figure 2 shows several oblique views of the esophagus, representing the similarities that may create confusion between an aberrant right subclavian artery and an esophageal diverticulum.

Following this interpretation, the right brachial and subclavian arteries were catheterized in the manner previously described, and the opaque catheter was observed fluoroscopically to pass obliquely downward from the right axilla, cross the midline posterior to the esophagus, hug the previously discovered esophageal defect, outlined with barium, and to enter the aorta in the descending portion of the arch. Roentgenograms made during the catheterization show the catheter lying within the lumen of the right subclavian artery and turning downward to pass obliquely behind the horizontal portion of the barium-filled esophagus and then into the aorta (Fig. 3).

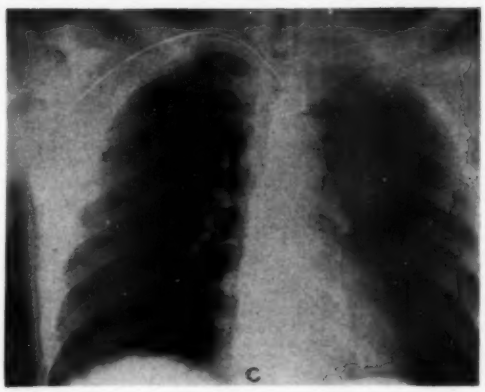


Fig. 3. Special opaque catheter lying within the brachial, axillary, and right aberrant subclavian artery and passing behind the esophagus. (The catheter has been retouched for clarity in reproduction). *a*. Left anterior oblique. *b*. Right anterior oblique. *c*. Postero-anterior.

The essential features in the diagnosis of this lesion by the above-described method were supplemented by spot roentgenograms made in the postero-anterior and both anterior oblique projections (Fig. 4). In the left anterior oblique view in the case reported the catheter is seen to pass behind the esophagus (Fig. 4a), while in the normal subject it passes in front of the esophagus (Fig. 4d). This single feature is of signal importance. The difference in the postero-anterior projections is not nearly as marked (Fig. 4b and e). One also notes striking differences in the appearance in the right anterior oblique projection

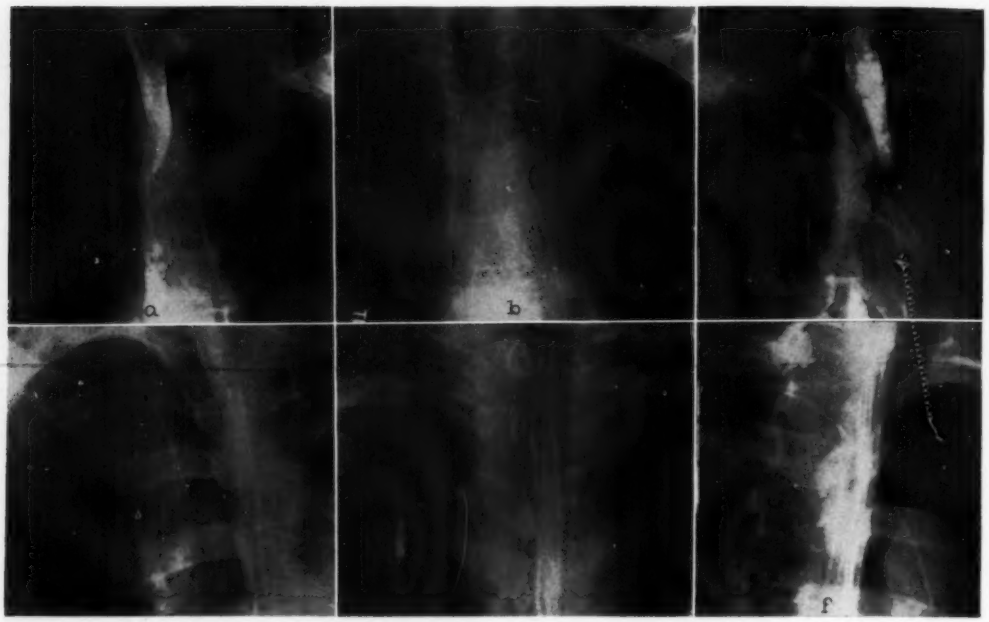
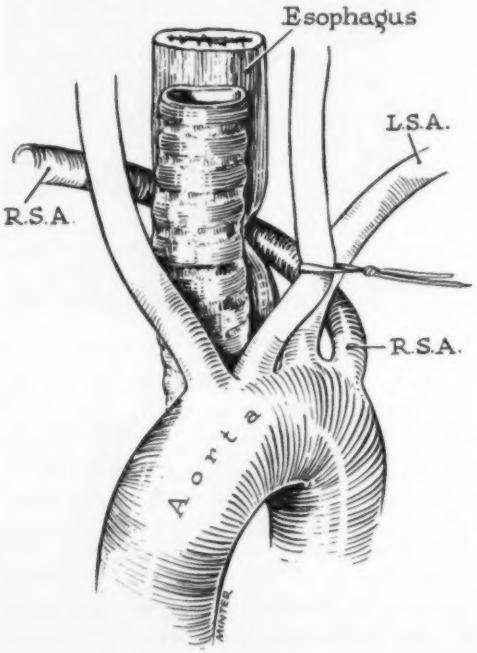


Fig. 4. a. Left anterior oblique projection showing catheter passing behind the esophagus.
b. Postero-anterior view in case of anomalous artery.
c. Right anterior oblique projection demonstrating catheter lying within the compressed area of the esophagus.
d. Left anterior oblique view demonstrating the normal anterior relationship of the right subclavian artery as it crosses the esophagus.
e. Postero-anterior view in case of normal artery.
f. Right anterior oblique view with catheter within right subclavian artery pursuing a normal course.



(Fig. 4c and f); the compression of the esophagus by the aberrant artery itself is here very evident.

A study of a schematic drawing of the relationship of an aberrant artery to the normal structures (Fig. 5) will aid in the interpretation of the roentgenographic findings.

The relationship of our patient's symptoms to the demonstrated vascular anomaly is not clear.

SUMMARY

1. A new method of radiologically observing the actual course of an aberrant right subclavian artery using arterial catheterization is illustrated with the report of a case.

2. The catheterization does not involve surgical procedure or demonstrable damage to the artery catheterized.

Fig. 5. Schematic drawing of aberrant right subclavian artery (modified from Brean and Neuhauser).

3. This new method is much less intricate, more certain, and less dangerous to the patient than angiocardiography, the only other decisive diagnostic procedure available for confirming the diagnosis of an aberrant right subclavian artery during life, other than by surgical intervention.

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SUMARIO

Nuevo Método para Descubrir una Arteria Subclavia Derecha Aberrante

La nueva técnica descrita permite descubrir el trayecto de una arteria subclavia derecha aberrante cuando se sospecha la presencia de la misma por los hallazgos radiológicos obtenidos durante los estudios del esófago con bario. Se punza la arteria humeral derecha con una aguja especial No. 19, de paredes delgadas, a través la cual se introduce y empuja, bajo orientación radioscópica, una sonda radioopaca, de 70 cm. de largo, pasándola por las arterias humeral y subclavia hasta la porción descendente del cayado de la aorta. La radioscopia y las radiografías obtenidas con la sonda en posición en la luz del vaso revelan el trayecto real de la arteria subclavia y su punto de entrada en la aorta.

Preséntase un caso en el cual se confirmó de esa manera el diagnóstico. El método parece ser menos complicado, más seguro y menos peligroso que la angiocardiografía.

Thrombosis of the Internal Carotid Artery[1]

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In 1936, Egas Moniz, Almeida Lima, and de Lacerda (17) reported a group of four cases of cervical occlusion of the internal carotid artery in which the diagnosis was established by carotid arteriography. Prior to this, the diagnosis had rarely been made antemortem. Following Moniz's demonstration, reports by other workers soon appeared in the literature. Löhr (14), Shimidzu (21), Chao *et al.* (4), Riechert (19), Siegert (22), Sorgo (23, 24), Andrell (1, 2), and many others (5, 8, 12, 15, 25, 26, 29) published similar cases. The increasing number of such reports indicates that internal carotid thrombosis is not infrequent as a cause of neurological disturbances. As a matter of fact, cervical thrombosis of the internal carotid artery accounted for 0.8 per cent of all cases of suspected brain lesions in Moniz's arteriographic material (16).

ETIOLOGY AND PATHOLOGY

The following conditions have been responsible for occlusion of the internal carotid artery:

1. Embolism
2. Thrombosis
   - (*a*) Arteriosclerosis
   - (*b*) Thromboangiitis obliterans (10)
   - (*c*) Syphilis
   - (*d*) Inflammatory changes in the intima due to rheumatic fever
   - (*e*) Direct trauma
   - (*f*) Compression from without (*e.g.*, sphenoidal ridge meningioma, subdural hematoma, etc.)

In the majority of cases, arteriosclerosis is the principal etiologic factor. In a comprehensive study of 3,500 autopsies, Hultqvist (11) found arteriosclerotic changes in the internal and common carotid arteries in 91 cases (2.6 per cent). In 69 cases the arteriosclerosis was gross, while in 22 cases the findings were noted only microscopically. In a comparable series, Keele (13) found the most marked sclerosis in the carotid vessels to be just below the point of bifurcation. Saphir (20) reported similar changes in the internal carotid artery in its course through the carotid canal and cavernous sinus. These changes were not limited to the older age group but were found also in young individuals.

Sorgo (23) suggested that trauma was a relatively frequent factor in the past history of his case material. In most of the cases reported in the literature, however, recognizable trauma was notably absent, exclusive of a small group of patients with an acute violent neck injury (3). Wolfe (29) makes the interesting speculation that carotid thrombosis may be similar to that found in the femoral and popliteal arteries in young men. The latter type of thrombosis was frequently seen during the recent war and was thought to be due to repeated minute intimal injuries from muscular exertion.

There are two sites of predilection for carotid thrombosis: (*a*) just beyond the division of the common carotid artery into its internal and external branches and (*b*) the region of the carotid siphon (18).

At operation, the diameter of the involved internal carotid artery is frequently found to be reduced in caliber and the lumen obliterated by a thrombus of varying color and firmness, depending on the duration of the process.

SYMPTOMATOLOGY

The clinical picture following thrombosis of the internal carotid artery may vary considerably, depending upon the extent of the occlusion, the rapidity with which it de-

[1] From the Departments of Radiology, Hospital of St. Raphael and Yale University School of Medicine. Accepted for publication in May 1951.

velops, the size and extent of the anastomoses in the circle of Willis, and the intracranial distribution of the various branches of the artery.

The lesion is most common in the fifth decade, although it may occur as early as the first decade. Some of the cases of sudden apoplexy in children listed by Ford (7) were probably due to internal carotid occlusion. Like other thromboses, carotid occlusion is more common in males. Most of the patients have an initial prodromal stage of varying duration, during which periodic symptoms suggestive of cerebral anoxia may be present. The onset, however, may occasionally be quite sudden. Likewise, the final thrombotic episode may be gradual or apoplectic. The former is more common, and most patients complain of unilateral headache and dizziness.

The maximal softening is in the distribution of the middle cerebral artery. The first objective neurologic manifestation is usually a contralateral spastic hemiparesis involving chiefly the arm. Moniz states that a characteristic feature of the hemiplegia is the minimal facial involvement. Occasionally, there may, however, be an associated contralateral facial paralysis. The paresis varies considerably in severity. It may be transient and slight initially and then progress to a hemiplegia, or it may be full blown from the beginning. Contralateral hemianesthesia and hemianopia are frequently present. If the thrombosis is left-sided, aphasia is likely to occur. This is usually transient at first, and tends to come on following the development of the hemiparesis.

Occasionally the onset and development of symptoms are so slow that they mimic a space-occupying lesion. In this group, epileptiform attacks and mental deterioration are commonly found along with the slow progression of the transient hemiparesis to a more complete hemiplegia.

VISUAL CHANGES

Transient diminution or loss of vision may occur. This visual loss has been attributed to vasospasm and may disappear after a few days. However, gradual progressive diminution of vision with eventual partial optic nerve atrophy is more common. Sudden unilateral blindness with subsequent complete atrophy of the optic nerve may also occur, but is rare because of the rich anastomotic network between the ophthalmic artery and the various branches of the internal maxillary artery. (9, 28).

COLLATERAL CIRCULATION IN THE ORBIT

The ophthalmic artery usually arises from the medial aspect of the internal carotid artery just after the latter vessel has left the cavernous sinus. Interestingly enough, there is often a marked reduction in the caliber of the internal carotid artery after it has given off its ophthalmic branch (27, 28). The ophthalmic artery then passes through the optic canal within the dural sheath of the nerve and provides the principal blood supply to the orbit. Frequently, the lacrimal artery, and occasionally the ophthalmic artery, may arise from the middle meningeal artery.

The important anastomoses between the ophthalmic artery and the internal maxillary artery branches are as follows:

1. The *recurrent meningeal branch of the lacrimal branch of the ophthalmic artery* passes back through the sphenoidal fissure or through a foramen in the greater wing of the sphenoid to anastomose with the *middle meningeal branch of the internal maxillary artery*. At times, this anastomosis may be quite large.
2. The *temporal and zygomatic branches of the lacrimal branch of the ophthalmic artery* anastomose with the *anterior deep temporal artery* (*a branch of the internal maxillary artery*) and the *transverse facial artery* (*a branch of the superficial temporal artery*) before the latter leaves the parotid gland.
3. The *supraorbital branch of the ophthalmic artery* arises where the ophthalmic artery lies above the optic nerve. It pierces the supra-

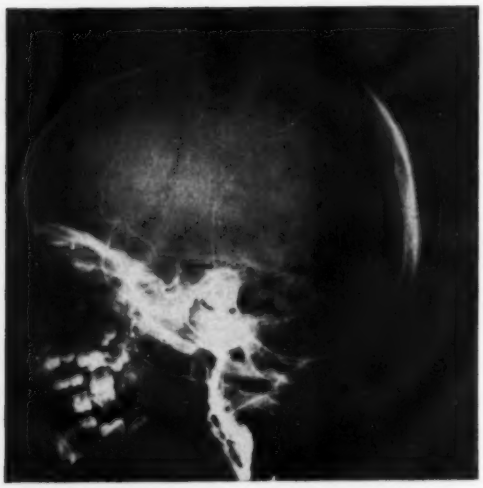

Fig. 1. Case I. Occlusion of left internal carotid artery in the region of the siphon. Note the large ophthalmic artery.

orbital foramen to reach the scalp and there anastomoses with the *superficial temporal branch of the external carotid artery.*

4. The *nasal branch of the ophthalmic artery* pierces the septum orbitale to supply the skin of the root of the nose and the lacrimal sac. It anastomoses with the *angular and nasal branches of the facial artery,* in turn a branch of the external maxillary artery.
5. The *frontal branch of the ophthalmic artery* pierces the septum orbitale to supply the skin, muscles and periosteum of the medial aspect of the forehead. It anastomoses with the *supraorbital branch of the ophthalmic artery and with its fellow of the opposite side.*

ROENTGEN DIAGNOSIS

Carotid arteriography is the keystone of diagnosis of thrombosis of the internal carotid artery. The findings are classical. Repeated attempts to visualize the artery on the involved side proximal to the thrombosis are unsuccessful. Usually there is excellent filling of the external carotid branches. If the occlusion occurs proximal to the origin of the ophthalmic artery, this vessel is usually enlarged and its anastomosis with the branches of the internal maxillary artery in the orbit can frequently be demonstrated.

In Andrell's series (2), 6 patients had encephalograms. In 5 of the group there was dilatation of the homolateral ventricle and in 2 there was also an increase in the subarachnoid marking over the homolateral convexity. These findings are nonspecific and merely represent indirect evidence of the resultant cerebral atrophy.

REPORT OF CASES

CASE I: *Thrombosis of the Left Internal Carotid Artery in the Region of the Siphon.* J. S., a 5-year-old boy, was admitted on Feb. 15, 1948, with difficulty in speaking and right-sided weakness. He had been well until four days prior to admission. As he was running toward his mother, his face suddenly became flushed and he began to cry. Loss of consciousness followed, lasting for half an hour. No convulsions occurred. After he recovered consciousness, the child was unable to speak or move his right arm and leg. These symptoms persisted for approximately one hour. Speech then returned but it was indistinct and thick. It improved the following morning, and the paralysis cleared somewhat, but at noon, aphasia was noted and the paralysis became more marked. Two days before admission, the patient had considerable difficulty in swallowing, but this had completely disappeared at the time of admission.

Physical examination revealed a complete motor aphasia, a right homonymous hemianopsia, and a right facial weakness. The patient, who was left-handed, had a complete right-sided flaccid paralysis. There were absence of abdominal reflexes on the right and a positive right Babinski.

On Feb. 15, the patient began to move his right arm and leg. An electroencephalogram showed a left-sided focus, maximal in the left temporal region. Open left-sided carotid arteriography was done (Fig. 1). Speech and motor power to the right arm and leg slowly returned and the patient was discharged on March 7, considerably improved. He was followed in the out-patient department and by July 1948 his speech and motor power were entirely normal. The next year he successfully completed his first year of school.

CASE II: *Thrombosis of the Left Internal Carotid Artery Somewhere Between the Cervical Portion and the Carotid Canal.* F. H., a 56-year-old man, was admitted on Jan. 10, 1949, complaining of gradual loss of function of the right leg. Six years before, he had arisen one morning and noted paresthesia and weakness of the right leg. The leg failed to improve, and after a few months he began to drag it. Six

months prior to admission, the weakness of the extremity became worse. Two months later the patient became aware of a "zing-zing" sound in his head, transient at first but soon becoming constant. He noticed that the sound was associated with the beating of his heart. One week before entering the hospital, he momentarily lost complete use of his right arm and his speech became garbled and thick. The right side of his face felt numb. In approximately three minutes, there was complete return of function. At no time was there loss of consciousness.

Physical examination revealed an audible bruit over the left eye, which could be obliterated by compression of the left carotid artery. Neurologic study disclosed a marked motor weakness of the right lower extremity, with hyperactive knee and ankle jerks on the right and a positive right Babinski. A provisional diagnosis of arteriovenous aneurysm in the intracranial portion of the left internal carotid artery was made.

An electroencephalogram was normal. On Jan. 14, closed left carotid arteriography was performed, followed by open arteriography on Jan. 24 (Figs. 2 and 3). Gradual digital compression of the left common carotid artery over a period of days was done. On Jan. 29, the left external carotid artery was ligated.

Postoperatively the bruit disappeared for four hours, only to return with less intensity thereafter. The patient was discharged on Jan. 27. When he was last seen, Sept. 18, 1950, no significant change in status had occurred.

The occlusion is probably somewhere between the cervical region and the carotid canal. At the time of the open arteriogram, the internal carotid artery near the bifurcation of the common carotid artery appeared grossly normal. However, no opacification of the cervical portion of the internal carotid artery was noted on any occasion, even when the external carotid artery was compressed. Possibly the return of the bruit following external carotid ligation can be explained by filling from both external carotid arteries with an anastomosis across the midline.

CASE III: *Cervical Thrombosis of the Left Internal Carotid Artery.* A 44-year-old woman was admitted on Jan. 3, 1951, complaining of recurrent syncopal attacks of two years' duration. These episodes oc-

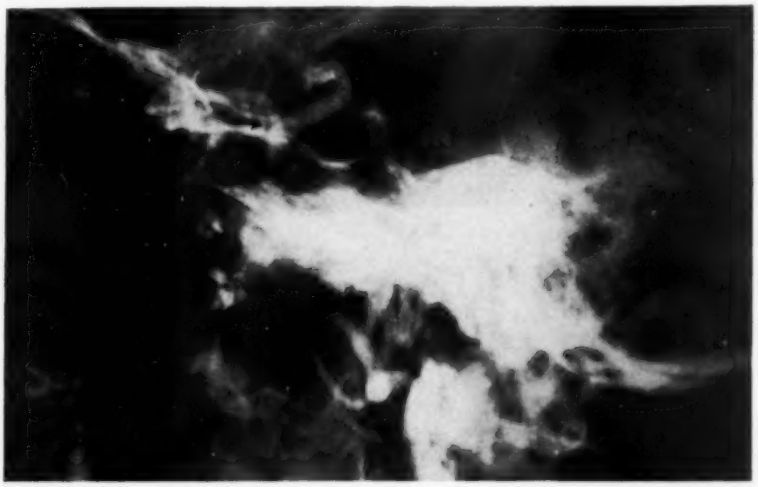

Fig. 2. Case II. Thrombosis of the left internal carotid artery between the carotid canal and the neck. Note the retrograde filling of the internal carotid artery *via* the rich orbital anastomoses.

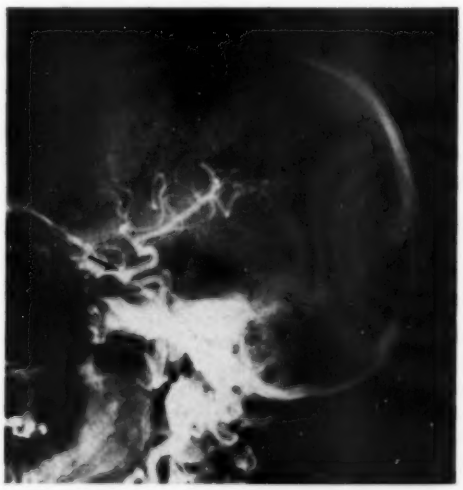

Fig. 3. Case II. Film made slightly later than Fig. 2. Note absence of filling of the cervical portion of the internal carotid artery; also the large ophthalmic artery.

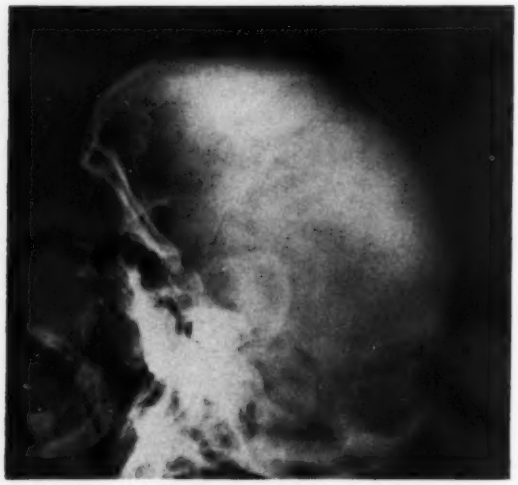

Fig. 4. Case III. Cervical thrombosis of the left internal carotid artery. Only external carotid filling seen.

curred once or twice monthly. During the attacks, there was a prodromal aura consisting of generalized weakness and dizziness which terminated in a complete "blacking-out."

Physical examination revealed normal right carotid pulsations in the neck. The left carotid artery in the cervical region was definitely firm and thickened, with very weak pulsations. Digital compression of the right carotid artery produced a typical syncopal attack. Compression of the left carotid artery was uneventful.

On Jan. 14, 1951, a left percutaneous carotid arteriogram was attempted but proved unsuccessful. On Jan. 17 a periarterial procaine block of the left common carotid artery was done. Approximately five minutes later there was a definite increase in the thrust of the carotid pulsations on the left side which lasted for approximately five minutes. The patient then suddenly began to complain of generalized weakness and felt as though she were going to experience another syncopal attack. Simultaneously, the pulsations in the left carotid artery became barely palpable.

On Jan. 20 open left carotid arteriography was done. At no time was there any filling of the internal carotid artery. On the other hand, there was excellent visualization of the external carotid artery (Fig. 4). Direct inspection of the neck vessels revealed a normal bifurcation. However, 1 cm. beyond the bifurcation, the internal carotid artery was thickened and reduced in caliber. No pulsations were present in the internal carotid artery.

The patient was discharged on Jan. 27, 1951, with no significant change in the clinical picture.

SUMMARY

Occlusion of the internal carotid artery occurs fairly frequently. Its diagnosis depends upon a high index of suspicion and the utilization of carotid arteriography. Three cases are reported.

NOTE: The author expresses his thanks to Dr. W. J. German for permission to use Cases I and II, and to Dr. F. Robinson for permission to use Case III. The author is also grateful to Dr. Arnold Janzen for the films in the first two cases.

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SUMARIO

Trombosis de la Carótida Interna

La oclusión de la carótida interna es bastante frecuente, basándose el diagnostico en una sospecha agudizada y en la utilización de la caroticoarteriografía. Los hallazgos son clásicos. Los esfuerzos, aun repetidos, para visualizar la arteria del lado afectado proximal a la trombosis fracasan invariablemente. Por lo general, el henchimiento de las ramas de la carótida externa es excelente. Si la oclusión es proximal al punto de origen de la arteria oftálmica, ésta suele estar hipertrofiada y puede a menudo observarse su anastomosis con las ramas de la arteria maxilar interna.

Preséntanse 3 casos.

Radiographic Diagnosis of Hydrocolpos in Infants[1]

LOUIS L. KLOSTERMYER, M.D., and JOHN J. THOMPSON, M.D.

ANY INFANT presenting an abdominal mass offers a diagnostic problem. Among other things, the differential diagnosis must take into account the tumors of the genito-urinary tract. Of this group there is one, hydrocolpos, which though of low incidence is important because a preoperative diagnosis leads to the simple corrective procedure of aspiration of the distended vagina. Without proper diagnosis, an exploratory abdominal operation may be performed which, if successful—and the mortality rate is high—may lead to a panhysterectomy. The importance of the correct diagnosis can therefore be appreciated. The part played by the radiographic findings in leading the radiologist at least to suspect the condition will be emphasized in this paper.

The literature contains reports of imperforate hymen or atresia of the vagina producing distention of the vaginal canal (hydrocolpos), and sometimes of the uterine canal (hydrometra), by fluid. The infant with the non-patent genital tract may display progressively severe symptoms related to urination and defecation, as the blind tract becomes distended with the abnormally increased secretion of the glands of the cervix. If the congenital defect

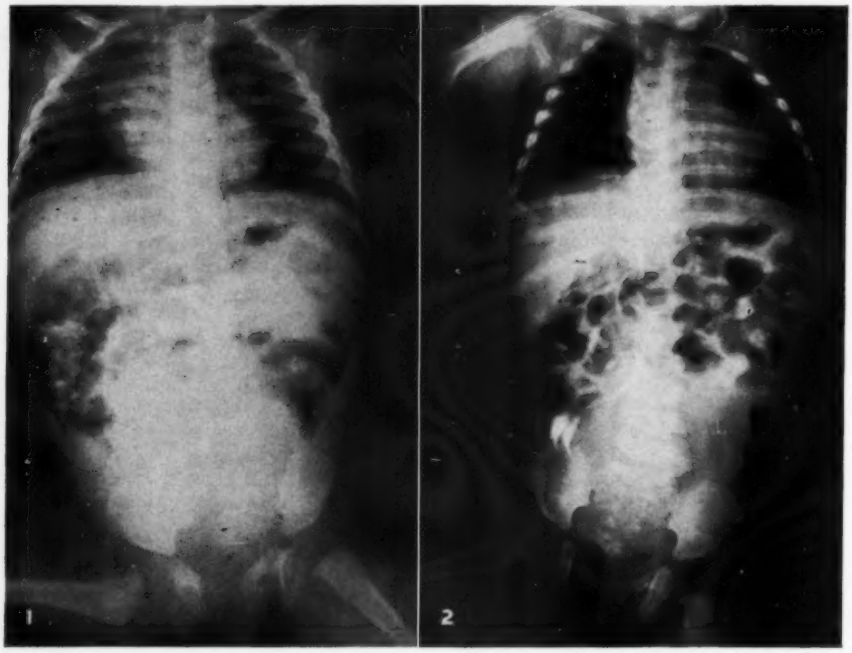

Fig. 1. Scout film of the abdomen: dome-like soft tissue density in the lower abdomen which persisted after catheterization.

Fig. 2. Excretory urogram. The soft-tissue mass displaces the right ureter laterally. There is left hydronephrosis. The left ureter cannot be identified.

[1] From the X-Ray Department, Mountainside Hospital, Montclair, N. J. Accepted for publication in April 1951.

does not produce symptoms in infancy, they may be delayed until puberty, when the significant finding is amenorrhea.

REVIEW OF THE LITERATURE

The chief complaints recorded for 13 reviewed cases of hydrocolpos occurring in infants were interesting for their great variety. They were, in 4 instances, urinary retention; in 3, swelling of the vulva; and, in one case each, diarrhea, imperforate anus, large lower abdominal mass, swelling and discoloration of the lower extremities, and a mass in the labia genitalia.

The one most consistent finding is a low abdominal mass. In only one instance was this not reported. In this latter case, however, the hydrocolpos was of secondary importance to an imperforate anus. Most of the reported cases list the next most consistent finding, a bulging mass in the region of the vulva. When this is present, it is made more prominent by crying, defecation, and abdominal pressure.

The other, less consistent findings are associated with the urinary and digestive tracts. Pyuria with urinary retention was described in 4 cases, and in 2 cases pyuria was found but no mention of retention was made. In 1 case there were associated hydroureter and hydronephrosis. Abnormal bowel habits were present in 3 patients: 1 had alternating diarrhea and constipation, another had diarrhea only, and a third had ribbon stools.

REPORT OF CASE

D. B.'s birth was uncomplicated (weight 8 lb. 2 oz.) and during eight hospital days she presented no signs of abnormality. When three weeks of age, she cried frequently, straining as though in an attempt to expel gas. The weight at that time was 8 lb. 4 oz., and complete physical examination was reported as negative.

When the child was two months old, she was admitted to the hospital, presenting symptoms of restlessness, excessive crying, and occasional vomiting. The temperature was 104°. Physical examination revealed an injected pharynx, a moderately distended abdomen, and a small umbilical hernia. The chest was clear. The extremities and genitalia were reported normal. Throat culture yielded hemolytic streptococcus. The urine contained 75 pus cells per high-power field and showed *E. coli* on culture. A blood count showed moderate anemia, 2,930,000 red cells, 7.4 gm. hemoglobin, 9,300 white cells. Treatment was instituted for upper respiratory infection and pyelitis.

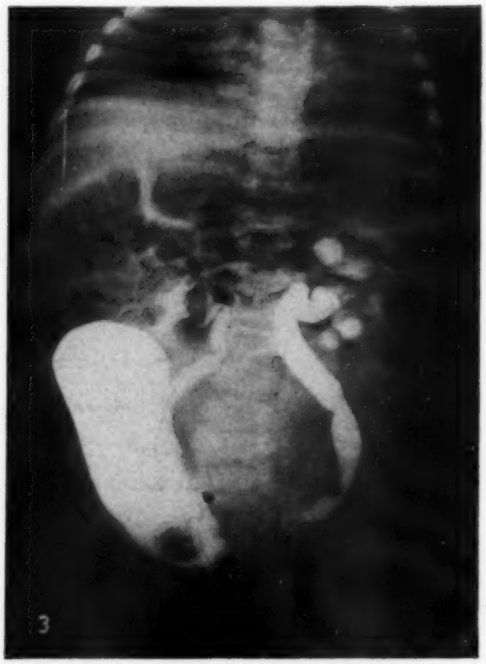

Fig. 3. Retrograde pyelogram. The bladder is compressed and displaced. There are left hydroureter and hydronephrosis with marked separation of the lower ureters.

On the sixth hospital day a roentgenogram of the chest was clear; a scout film of the abdomen revealed a dome-like density in the lower abdomen (Fig. 1). This persisted after catheterization, which yielded 75 c.c. of urine, and a rounded smooth mass was then palpated low in the abdomen.

The pharyngitis subsided, but pyuria persisted, and on the sixteenth hospital day cystoscopic examination was done. The bladder was injected and displaced to the right, the distortion obscuring the ureteral orifices.

Rectal examination revealed a mass anterior to the rectum, practically filling the pelvis and extending into the abdomen. A second cystoscopy confirmed previous findings as to the bladder, but an attempt to locate the ureteral orifices for catheterization and pyelography was unsuccessful. The following day excretory urography demonstrated lateral displacement of the right ureter and left hydronephrosis (Fig. 2).

Six days later cystoscopy and retrograde pyelography were done by Dr. Meredith F. Campbell

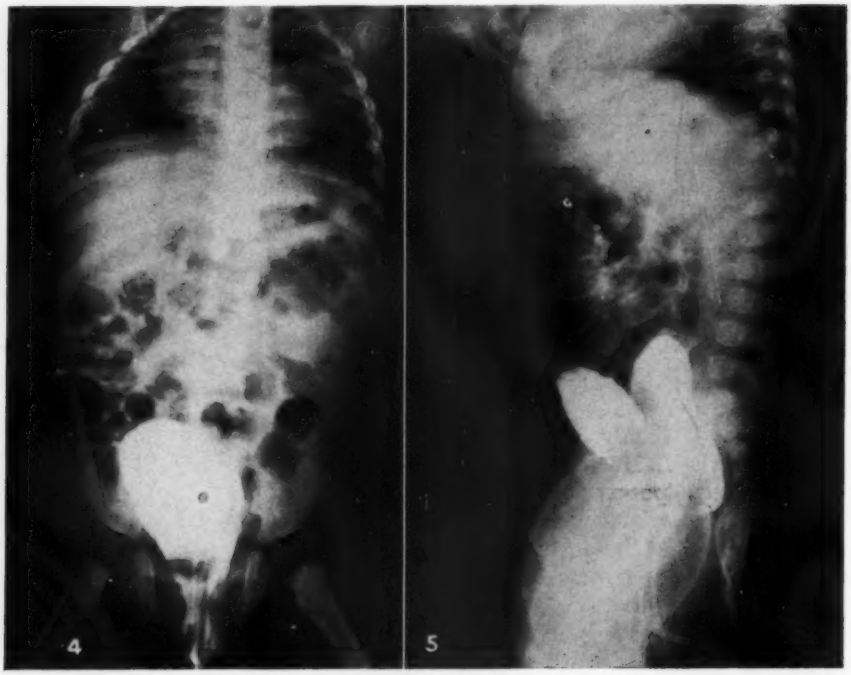

Fig. 4. Combined cystogram and vaginogram, twenty-four hours after evacuation of the hydrocolpos.

Fig. 5. Combined cystogram and vaginogram, lateral projection, demonstrating position and relative size of the bladder and distended vagina.

(Fig. 3). The bladder was elongated, displaced to the right and forward. Both lower ureters were displaced laterally. Grade two hydroureter and hydronephrosis were present on the left, with delayed indigo carmine excretion.

The possibility of imperforate hymen and hydrocolpos was checked by physical examination, which showed a small hymen, reddish gray in color, which protruded slightly with straining. It was incised and over 3 oz. of gray cloudy fluid were evacuated. The lower abdominal mass disappeared and the infant promptly went into shock. A smear of the vaginal fluid was negative for pus cells or bacteria, but *E. coli* and *Staphylococcus albus* grew on culture.

The day following incision of the hymen, a cystogram and vaginogram were obtained, diodrast being used as contrast medium (Figs. 4 and 5).

All symptoms subsided rapidly and follow-up examinations in the clinic for the ensuing six months demonstrated rapid correction of anemia, control of the urinary tract infection, and no persistent vaginal discharge.

CONCLUSION

The radiologist may be the one to suggest the diagnosis of hydrocolpos. He must have first been alerted to the possibility by the finding of a soft-tissue mass in the lower abdomen, associated with distortion of the urinary bladder and with separation of the ureters. When the diagnosis has been confirmed by careful inspection of the genitalia, simple aspiration through the hymen will evacuate the vagina and remedy the condition, thus eliminating the ever-present temptation to explore the abdomen, with the added risk of unnecessary mutilation or mortality.

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SUMARIO

Diagnóstico Radiográfico del Hidrocolpos en los Lactantes

El caso comunicado es de hidrocolpos diagnosticado por el estudio roentgenológico complementado por el examen físico. En este estado, el hallazgo más constante, según indica un repaso de la literatura, consiste en una tumefacción en la porción inferior del abdomen, que puede ir acompañada de distorsión de la vejiga urinaria y separación de los uréteres, reveladas por los rayos X. El diagnóstico, sugerido por esos hallazgos, puede ser confirmado por la inspección de los genitales, la cual mostrará un himen imperforado o atresia vaginal. La evacuación de la secreción de la vagina por la mera aspiración a través del himen remediará la situación y evitará una exploración abdominal que podría culminar en la muerte o una histerectomía.

Anterior Sacral Meningocele[1]

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ANTERIOR SACRAL meningocele is a relatively rare entity which, because of varying signs and symptoms, may be a problem for the surgeon, the gynecologist, the neurologist, the urologist, the pediatrician, or the neurosurgeon. It is the radiologist, however, who ultimately is required to make or confirm the diagnosis.

A review of the literature relating to anterior sacral meningocele was made by Coller and Jackson in 1943 (1); they found 22 previously reported cases and added 1 of their own. Since then 3 additional cases have been contributed by Shidler and Richards (2), 1 by Ingraham and Hamlin (3), 2 by Flickinger and Masson (4), 1 by Alexander and Stevenson (5), 1 by Brown and Powell (6), and 3 by Sherman, Caylor, and Long (7). A comprehensive review of the world literature was provided in 1949 by Eder (8), in which he tabulated 45 cases including 1 of his own. (Eder did not list the case reported by Brown and Powell, and Sherman, Caylor, and Long published their 3 cases in 1950, subsequent to Eder's study.) It is the purpose of this paper to describe 3 cases seen in the Strong Memorial Hospital (Rochester, N. Y.). They bring to at least 52 the examples of anterior sacral meningocele so far recorded.

Anterior sacral meningocele is a congenital anomaly characterized by agenesis of a part of the anterior portion of the sacrum, herniation of meninges through the defect, and formation of a hernial sac in the pelvis. The presence of the anterior defect differentiates this anomaly from the more common posterior sacral meningocele caused by failure of fusion of posterior sacral arches. In the latter condition, propulsion of the hernial sac posteriorly permits the formation of an easily recognized protuberance of varying size on the posterior body wall. With anterior sacral meningocele, there is no external manifestation of the anomaly and the diagnosis is made on the basis of clinical suspicion and x-ray confirmation.

Symptoms, if any, are usually secondary to the pressure of the meningocele on the rectum and indirectly on the urinary bladder and other pelvic organs; constipation, frequency, urgency, and dysuria are the most common complaints. Dysmenorrhea and dyspareunia with headache may be present in women. Headache may also occur during and following bowel evacuation. The headache is presumably the result of pressure on the pelvic mass which, transmitted through the spinal canal, creates temporary alteration of the intracranial pressure. Physical examination may reveal the presence of a fluctuant mass high in the posterior rectal wall, or the examination may be negative.

Therapy depends on the seriousness of the symptomatology. The only effective treatment is surgical amputation of the hernial sac. This, however, is a major procedure and is not indicated unless the symptoms are so severe as seriously to incapacitate the patient. Aspiration through the rectal wall on the false assumption that the palpable, fluctuant mass is a perirectal abscess, invites meningitis from *Bacillus coli* and possible death.

The roentgenologic findings are characteristic. The agenesis of the anterior portion of the sacrum may be unilateral or bilateral and usually involves the lower half of the bone. The defect can be seen in routine anteroposterior roentgenograms of the pelvis (Fig. 1) and is presumptive evidence of the presence of anterior sacral meningocele. Further roentgenologic in-

[1] From the Department of Radiology, University of Rochester School of Medicine and Dentistry, Rochester, N. Y. Accepted for publication in June 1951.

vestigation may be undertaken to outline the hernial sac. Barium clysma may show anterior displacement of the upper portion of the rectum because of extrinsic pressure (Fig. 2). Ureterography and cystography may also be utilized to indicate pressure displacement. Definite proof of the lesion may be obtained by myelography. The radiopaque material injected into the lumbar subarachnoid space will migrate into the hernial sac, the size and shape of which may be demonstrated with the following projections and positions: lateral, supine (Fig. 4A); lateral. prone (Fig. 4B); anteroposterior with the patient lying on the side (Fig. 4C); anteroposterior erect (Fig. 3).

CASE REPORTS

CASE 1: A married white woman, 24 years old, was admitted to the hospital complaining of head pain associated with bowel movements. At about the age of fifteen she began to suffer headaches that occurred mainly when she became fatigued. They did not respond to medication but were alleviated by long periods of sleep. At the age of twenty, the patient had a prolonged episode of headache, nausea, and general malaise. At that time, the finding of a palpable rectal mass was the basis for a diagnosis of perirectal abscess. Treatment with sulfonamides was followed, after a short interval, by rectal examination which was thought to be negative. The patient was informed that the mass had disappeared and that she required no further treatment.

About four months prior to admission to the hospital, the patient experienced rather severe pain in the head associated with bowel movements. These pains, however, occurred only when the feces were formed and not when stools were soft or diarrheal in nature. General physical examination showed no abnormality. Pelvic examination was then carried out under anesthesia and, in the region of the cul de sac, a spheroid cystic mass measuring 6×10 cm. was encountered. During rectal examination, it could be easily identified as a relatively fixed mass occupying the hollow of the sacrum.

X-ray examination of the lumbar vertebrae and pelvis showed almost complete absence of the lower sacral segments with some remnants of pedicles or laminae. The images of a few structures, not clearly identifiable, extended somewhat more inferiorly on the left than on the right. There was a suggestion of a rounded soft-tissue mass occupying a position in the pelvis too craniad for it to represent the bladder. A myelographic examination with pantopaque injected into the third lumbar interspace revealed the vertebral canal to be normal above the level of the sacral defect. At this point there was a slight hold-up of flow of the oil, but with further tilting the pantopaque ran into a large cavity, the outer limits of which were approximately as follows: upper border —anterior to lower edge of first sacral segment; lower extremity—a point behind the pubic symphysis; lateral borders—points anterior to the sacroiliac joints. The anterior surface appeared to be quite irregular. A diagnosis of anterior sacral meningocele was made.

Because it was believed that the patient's symptoms could be controlled by maintaining soft stools, operative intervention was not carried out.

CASE 2: A 7-year-old white boy was referred to the hospital for x-ray examination because of chronic constipation since birth. There had been no other symptoms, and the question of Hirschsprung's disease was considered on admission. Physical examination was negative except for a sacral defect detected during rectal examination.

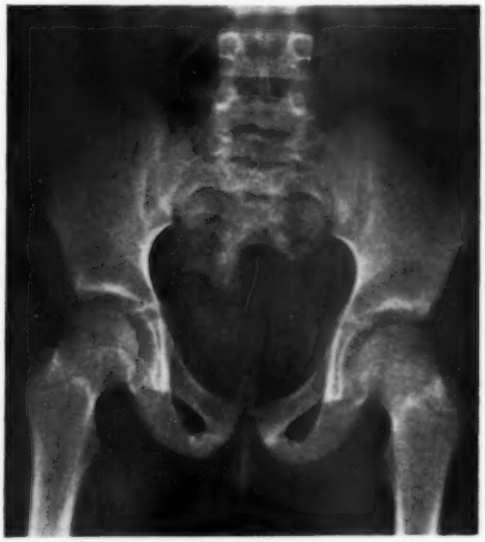

Fig. 1. Case 2. Anteroposterior film of pelvis, showing the defect in the left side of the sacrum, with absence of the usual bony structure.

An anteroposterior roentgenogram of the abdomen and pelvis (Fig. 1) revealed the presence of a small amount of gas and fecal material in the right half of the colon, and a large defect involving the left side of the sacrum, with absence of the usual bony structures. A soft-tissue shadow extending laterally and inferiorly from this defect was presumed to indicate the presence of an anterior meningocele. Barium clysma indicated that there was no narrowing of the lower rectal segment. On the other hand, the caliber of the sigmoid was markedly increased. This dilatation became progressively less as the barium passed

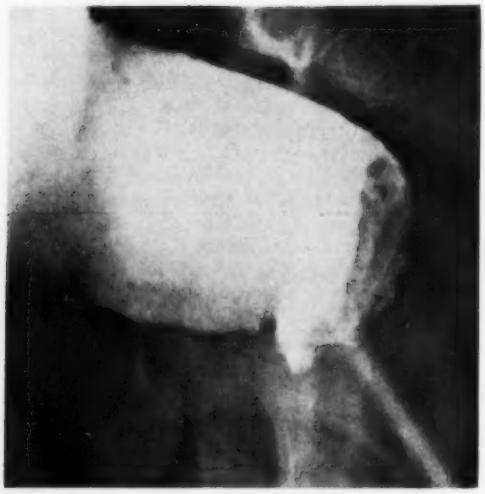

Fig. 2. Case 2. Lateral view of barium-filled rectum.

through the splenic flexure and into the cecum. Oblique and lateral roentgenograms (Fig. 2) showed definite anterior displacement of the posterior wall of the upper portion of the rectum. This was believed to be a consequence of the anterior sacral meningocele. The barium clysma could be evacuated satisfactorily from the major portion of the colon, but a moderate accumulation remained in the distended sigmoid. Myelography was carried out with 1 c.c. of pantopaque injected in the third lumbar interspace. When the patient was tilted caudad, the medium passed readily into a large cavity in the pelvis. The outlines of this hernial sac could be estimated by moving the patient in various positions. Some of the myelograms of this case are reproduced in Figures 3 and 4. Their interpretation confirmed the diagnosis of anterior sacral meningocele previously made.

Surgical intervention was decided against because it was felt that the symptoms were not severe and could be controlled by the judicious use of laxatives and enemas to maintain soft stools.

CASE 3: A white girl, 8 years old, was seen three times in the Emergency Department of the hospital because of nausea and pain in one side. The history was non-contributory, and during the first two admissions the physical findings were negative. On the third admission, the urine was clear, yellow, acid, and negative for sugar or albumin. A voided specimen indicated 4 to 10 white blood cells per high-power field, with occasional clumping. A urine culture was negative.

Intravenous pyelographic examination was then recommended. The preliminary anteroposterior radiograph of the abdomen and pelvis revealed agenesis of the lower left portion of the sacrum and absence of the coccyx. The rectum appeared to be displaced to the right. A homogeneous soft-tissue mass occupied the left half of the pelvic cavity. In the pyelograms the kidney shadows were normal in shape, size, and position and showed good concentration of dye. A diagnosis of anterior sacral meningocele was made.

The abdominal symptoms abated and the patient was discharged without surgical intervention.

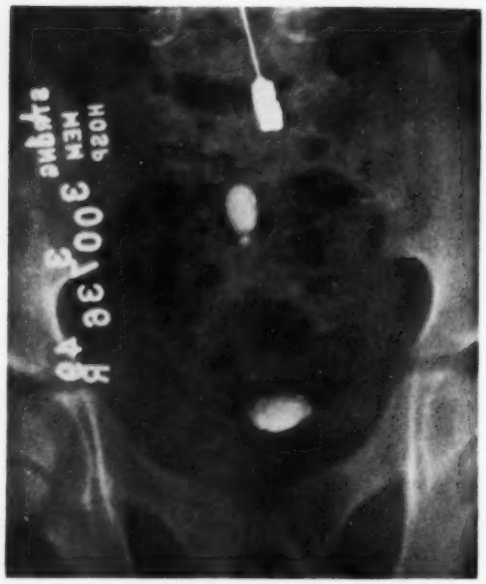

Fig. 3. Case 2. Anteroposterior film of pelvis with patient in erect position following injection of pantopaque into lower lumbar spinal canal.

SUMMARY

Three cases of anterior sacral meningocele are reported. The value of various roentgenologic examinations in making or confirming the diagnosis is stressed. These 3 cases bring to at least 52 the examples of this entity now recorded in the literature.

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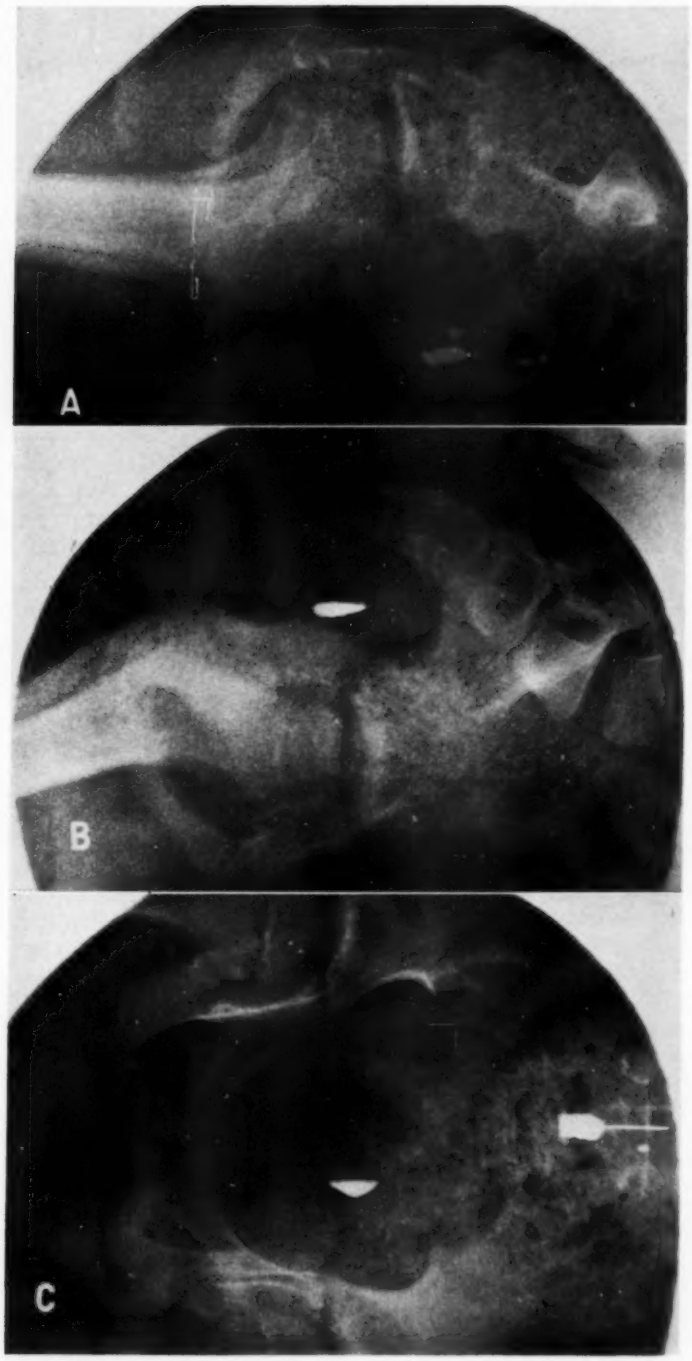

Fig. 4. Case 2. A. Lateral film of pelvis with patient supine after injection of pantopaque into lower lumbar spinal canal.
B. Lateral film of pelvis with patient prone after injection of pantopaque into lower lumbar spinal canal.
C. Anteroposterior film of pelvis with patient lying on left side after injection of pantopaque into spinal canal.

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SUMARIO

Meningocele Sacro Anterior

Comunícanse 3 casos de meningocele sacro anterior, lo cual eleva por lo menos a 52 el total comunicado en la literatura médica.

Los hallazgos roentgenológicos en este estado son típicos. En las radiografías anteroposteriores de la pelvis puede notarse la deformación del sacro, que constituye signo presuntivo de la afección. El estudio con enema de bario tal vez revele desplazamiento anterior de la porción superior del recto, debido a la presión extrínseca. La mielografía aporta prueba bien definida del diagnóstico. El medio radioopaco inyectado en el espacio subaracnoideo lumbar migrará al saco herniario, cuyo tamaño y forma pueden ser observados en varias posiciones.

Urinary Incontinence in Women: Roentgen Manifestations[1]

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In 1949 Muellner (3), using retrograde cystography, observed what appeared to be significant differences between continent and incontinent urinary bladders in women. Roentgen visualization of the urinary bladder being routine during intravenous urography, it occurred to us to investigate the reliability of Muellner's findings by this method rather than by the retrograde procedure. Our experience indicates that the two methods are equally effective.

Stress incontinence has for years been an interesting problem in female bladder physiology. Until recently it has been attributed to injury of the urethral sphincters or bladder supports at childbirth. Natvig (4) considered it to be due to failure of the bladder-closing mechanism resulting from insufficient support of the muscles of the pelvic wall. Thomsen (5) held that the bladder-supporting muscles were of secondary importance. In his opinion it was the urethral mechanism that was primary. He argued that there normally existed a point of fixation in the upper urethra, the loosening of which resulted in incontinence. Using urethrograms to confirm his opinion, he recommended supporting or tightening the anterior urethral wall to correct the condition.

Kennedy (2) appeared to hold an opposite view. He ascribed the incontinence to adhesions between the pubic rami and the urethra, for which he advised surgical separation. He believed that traumatization of the loosely suspended urethra at childbirth distorted and fixed the internal sphincter in such manner as to prevent the mucosal folds from filling the urethral canal and closing it tightly.

While it is true that obstetrical trauma probably is responsible for some cases of stress incontinence, it must be remembered that nulliparous women, too, complain of this difficulty. Significant, also, is the fact that many women with exertional incontinence prove to have normal pelves on manual and surgical exploration.

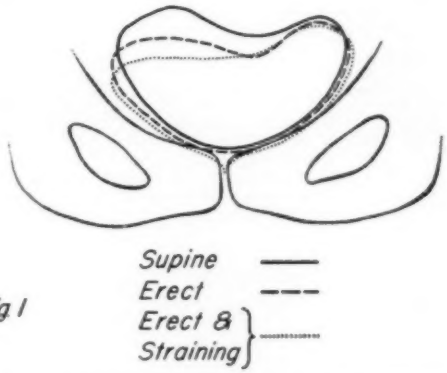

Fig. 1. Bladder outline in normal nullipara. *Supine:* Bladder base above symphysis. *Erect:* Little or no change in bladder outline. *Erect and straining:* Slight descent of bladder base and "pointing" at the internal sphincter.

Recent observations by Kegel and Powell (1) suggest that the syndrome may be due to functional neuromuscular deficiencies in the perivaginal and periurethral structures. The pubococcygeus portion of the levator sling particularly seems affected in the dysfunction. Thus, these authors have advocated re-education of the supportive and sphincteric muscles of the vesical outlet. The fact that 80 per cent of 300 patients so treated were completely relieved of their stress incontinence, and a further 10 per cent greatly helped, tends to support the hypothesis.

Muellner's recent observations also appear significant. This investigator concluded that there exists in the erect posture a dual mechanism for control of the female

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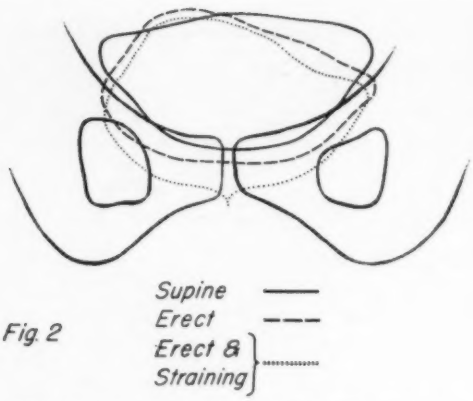

Fig. 2. Bladder outline in continent multipara. *Supine:* Outline larger than in nullipara, but base still very near superior margin of symphysis pubis. *Erect:* Slight descent of bladder base. *Erect and straining:* Further descent of base and "pointing" at internal sphincter.

urinary bladder: (1) the internal sphincter, which effectively shuts off the bladder, and (2) the muscles of the pelvic floor. Much of Muellner's work is based upon fluoroscopic and radiographic evidence obtained from urinary bladders rendered opaque by retrograde urethral injections. His observations indicate that marked incontinence may be present in patients with intact pelvic structures, while little or no incontinence may be present when the urethra and bladder have lost their attachment.

According to Muellner, the normal bladder in the nulliparous subject has a smooth outline with its base just above the symphysis pubis. This relationship it maintains in the erect position even on coughing, thus revealing the excellence of its supports. With straining or voiding, the base of the bladder descends sharply; the internal sphincter becoming its most dependent portion then assumes a teat-like or pointed appearance which may open to permit a few drops of radiopaque solution to enter the proximal urethra (Fig. 1). Contraction of the detrusor muscle follows with uninterrupted urination. With voluntary inhibition of the urinary stream, the bladder base quickly ascends to a plane slightly above its resting level, becoming horizontal as it shuts off the stream.

The continent bladder in the multipara looks somewhat the same and passes through a similar series of events, though it often seems larger and less well supported. Whereas in the recumbent posture it simulates the nulliparous viscus, it sinks lower in the erect posture, where it retains its even configuration. On coughing or straining, the base descends further as the teat-like pointed appearance at the bladder neck makes its appearance (Fig. 2).

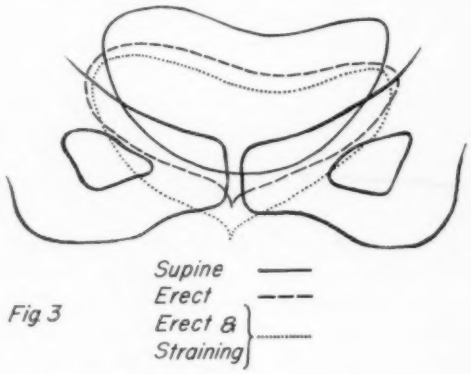

Fig. 3. Bladder outline in stress incontinence. *Supine:* Similar outline to normal nullipara and multipara. *Erect:* Descent of base, particularly in region of internal sphincter, giving diagnostic pointed appearance of stress incontinence. *Erect and straining:* Even more marked yielding of bladder base and sphincter.

In the incontinent woman, the radiopaque bladder also looks normal in recumbency. On standing, however, the teat-like pointed outpouching characteristic of the bladder poised for urination is observed in the absence of straining or coughing (Fig. 3). This configuration, the appearance of a urinary bladder poised to empty even though the patient stands relaxed, is typical of stress incontinence according to Muellner.

On coughing or straining, the region of the internal sphincter gives way as it takes up the downward thrust of the base of the bladder. The pubococcygeal muscle, being weak or atonic, fails to support the internal sphincter, as is necessary to stop micturition by elevating the base of the bladder. It then takes but little further stress and descent to open the internal sphincter, allowing urine to escape.

Fig. 4. Bladder in continent twenty-seven-year-old woman, para II (two Cesarean sections); uterine suspension one year previously; no urinary symptoms. A. *Supine:* Bladder base smoothly outlined above symphysis. B. *Erect:* Position of bladder base unchanged. C. *Erect and straining:* Slight descent of bladder base.

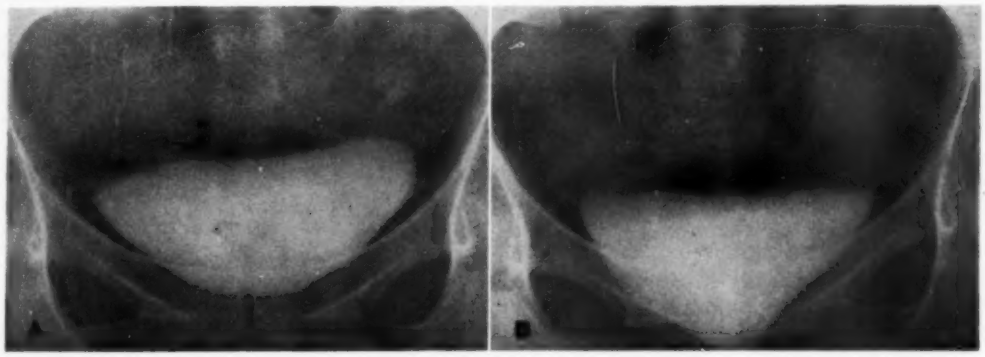

Fig. 5. Bladder in continent thirty-eight-year-old woman, para II, with typical symptoms and signs of ureteral calculus. A. *Erect:* Slight descent of bladder base below the pelvic brim. B. *Erect and straining:* Further descent of base of bladder, internal sphincter dilating and descending disproportionately to give a conical appearance.

Kegel and Powell's postulate that neuromuscular deficiencies are present in many women with stress incontinence seems supported by Muellner's observations. In the face of this etiologic concept, the roentgen study of the urinary bladder becomes increasingly important.

In our experience, urinary bladders are rendered sufficiently opaque by intravenous urography to demonstrate Muellner's criteria if urinary function is normal. One technical difficulty, inherent in all these studies, merits emphasis. The urinary bladder, in all projections, must be radiographed so as to maintain a constant relationship with the surrounding bones of the pelvis. Whereas changes in configuration of the base mimicking the teat-like point of a bladder poised for emptying cannot be produced by altered roentgen technic, it is helpful to be able to demonstrate descent of the bladder base with assurance.

The patient whose bladder is depicted in Figure 4 had two babies, both by cesarean section. This is a classical nulliparous bladder which descends insignificantly in the erect posture and upon straining. Figure 5 shows the bladder of a multipara, slightly below the pelvic brim in the erect posture (A), descending remarkably on straining (B). Attention is called to the smooth curved outline of the base of the bladder with the patient in the relaxed standing posture, which typifies the continent bladder.

In Figure 6, the classical teat-like appearance of the base of the bladder is observed in the relaxed standing posture in a woman with stress incontinence (A). The bladder is poised to empty. In B, this

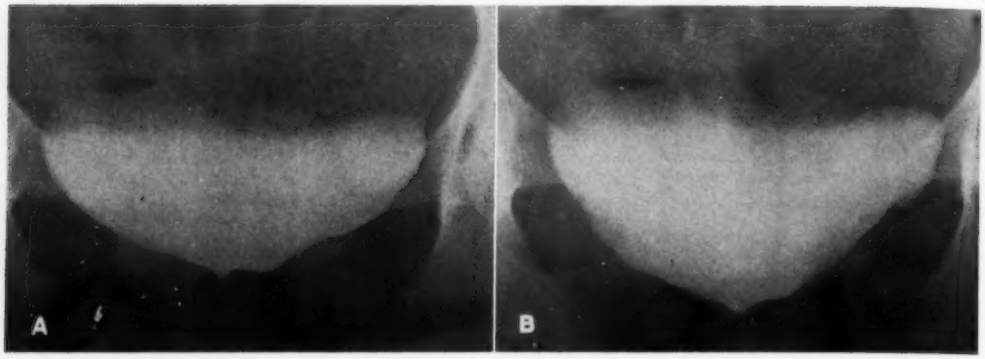

Fig. 6. Bladder in stress incontinence, in a fifty-year-old woman, para II, with history of forceps and perineal repair at each delivery; salpingectomy, uterine suspension, anterior and posterior vaginal repair at age thirty-one; anterior colporrhaphy for cystocele, urethrocele, and mild stress incontinence at age forty-eight, with incontinence recurring and becoming complete following surgery. Urethrovaginal fistula, cystocele, and urethrocele repaired by Aldrich method at age forty-nine. Urgency, enuresis, and uncontrollable voiding recurred, although pelvic examination showed good support of uterus. A. *Erect:* Typical bladder outline of stress incontinence with disproportionate descent and dilatation of internal sphincter, giving a pointed, teat-like appearance to the bladder base. B. *Erect and straining:* More marked descent of bladder base and internal sphincter.

bladder has descended considerably due to straining, a phenomenon common in continent multiparous women.

SUMMARY

1. The cause of stress incontinence in women has not been unequivocably established. Birth trauma may be a factor, but neuromuscular deficiencies in the pelvic floor seem to be more important.

2. Opacified urinary bladders in incontinent women show a teat-like outpouching in the relaxed standing position that is not seen in the continent patient.

3. Retrograde and intravenous technics of bladder opacification are equally effective in demonstrating altered configurations.

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SUMARIO

Incontinencia Urinaria en las Mujeres: Manifestaciones Roentgenológicas

No se ha establecido aun inequívocamente la causa de la incontinencia premiosa en la mujer. El traumatismo incidente a la gestación puede representar un factor, pero las deficiencias neuromusculares del piso pelviano parecen revestir mayor importancia.

Muellner ha descubierto con la cistografía una diferencia aparentemente significativa entre las vejigas continentes y las incontinentes. Los AA. han podido a su vez observar esa misma diferencia con la urografía intravenosa. Consiste la misma en la apariencia tetiforme o puntiaguda a modo de saco proyectante de la vejiga en la posición erecta reposada que se observa en la mujer incontinente y no en la continente.

EDITORIAL

Cobalt^{60} as a Source for Radiotherapy

Another important milestone has been passed in the search for tools to aid in research and the therapy of malignant disease. The almost simultaneous opening of the Cobalt^{60} Teletherapy units at the Victoria Hospital, London, Ontario, and at the University of Saskatchewan at Saskatoon must attract the attention of all who are interested in radiotherapy. These sources, which emit an adequate amount of highly penetrating radiation at a distance of up to one meter, represent the attainment of an objective sought since the epoch-making discovery of the Curies in 1898, a goal heretofore impracticable because of the high cost and limited supply of radium.

The history of radiotherapy has been one of constant and progressive improvement in equipment since the earliest attempts to use the newly discovered roentgen rays in 1896. The first real advances followed upon the introduction of the Coolidge tube in 1913, but it was not until apparatus developing 200 kilovolts became available in the period following World War I that modern deep therapy was made possible.

The basic unit for deep therapy has been more or less standardized at 200 to 250 kv., but machines have been constructed employing voltages of 1,000,000 to 2,000,000. In addition there are methods of employing electromagnetic induction, as with the betatron, which make possible the use of roentgen-ray beams with energies ranging upward from 20,000,000 volts. Announcement is made from time to time of other apparatus producing astronomical voltages, but most of these have as yet no application to radiotherapy of the human subject.

Radium has been in general use as a therapeutic agent since its discovery. It has been of particular value for intracavitary therapy and interstitial application, either in the form of needles containing the radium element or gold radon seeds, which are left *in situ*. Its employment on any considerable scale in teletherapy, which requires large quantities for an adequate time-dosage relationship, has been prevented by the relative scarcity of the element and its high cost.

Radioactive isotopes of various types produced by the cyclotron, and by the atomic pile, have been eagerly studied with the hope that here might be found an ideal low-cost substitute for radium. To be of value to the radiotherapist, such an isotope, according to Wilson, (1) must emit hard gamma rays, (2) must have a considerable half-life period, (3) must be produced readily in considerable quantities of adequate specific activity (*i.e.*, the amount of radioactivity present per gram of material), and (4) must have properties which render it convenient for the user.

A number of radioisotopes have been found to meet several of these requirements, but Cobalt^{60} has proved the most nearly ideal for the purpose of routine radiotherapy. It emits a relatively soft beta radiation of 0.31 mev energy, which is easily filtered out by 0.1 mm. of silver or its equivalent, and an almost homogeneous gamma radiation equivalent to 1.16 and 1.31 mev, which is so close to the gamma radiation emitted by radium that the dosage problem is similar. The half-life is 5.3 years, a period of sufficient length to be practical for long-continued use before renewal becomes necessary. Cobalt^{60} of a sufficiently high specific activity is now being produced that up to 2,000 curies

activity is contained in a single teletherapy unit. As to its convenience for the radiotherapist, it is a solid, which is relatively unbreakable, and it generates no radioactive gases. Suitable alloys are available which are magnetic and therefore easily handled when small units are used. Finally, it can be produced in any desired quantity within reason.

Morton, Callendine, and Myers have done notable pioneer work in the use of Cobalt^{60} for interstitial radiation therapy. They devised methods of loading multiple small units, cut from radioactive Cobalt^{60} wire, into nylon tubing to make flexible applicators which conform to the contours of tumor infiltration. These applicators are removable and the units may be used repeatedly. For use in the area of the uterine cervix, similar units were encased in stainless steel tubing. These needle-like applicators were implanted in the pelvic area through a lucite template to assure proper positioning.

The most recent application of Cobalt^{60} to the field of radiotherapy is in teletherapy, as mentioned above. The units presently in use have an output of 21.5 r per minute at a distance of 1 meter, with a 10 × 10-cm. field, including back-scatter, and 45 r in air at a distance of 70 cm. with a similar field. They are quite flexible for positioning and appear to be well shielded. The depth dose at 10 cm., with a source-to-skin distance of 70 cm. and a 10 × 10 cm. field, is 54 per cent; with a 15 × 15 cm. field it is 56.8 per cent.

To summarize briefly, in Cobalt^{60} a new tool has become available to the radiotherapist. It would appear, at the present time, to offer greater advantages than any of the other isotopes, due to its emission of hard gamma rays and soft beta rays, its relatively long half-life, and its high specific activity. Its cost promises to be reasonable in comparison with radium. Already it has been given a convincing therapeutic trial in intracavitary and interstitial applications. Telecobalt therapy is only in its beginning, but there is no reason to believe that its effect on tumor tissue will vary from that of other similar forms of radiation. It may be pointed out, further, that with the use of multicurie units, the radiologist will be faced with new and serious problems of protection.

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NOTICE TO ALL DIPLOMATES OF THE AMERICAN COLLEGE OF RADIOLOGY

There have been many changes of address among the diplomates of the American College of Radiology in recent years and we find that frequently we have not been notified of them. If any diplomate has changed address since certification and has not advised us, we would appreciate it if he would notify us of his present address. This will enhance our records and simplify the preparation of the next edition of the *Directory of Medical Specialists.* Notices should be sent to the undersigned.

B. R. KIRKLIN, M.D.
Mayo Clinic
Rochester, Minn.

ALABAMA RADIOLOGICAL SOCIETY

The recently elected officers of the Alabama Radiological Society are: President, Dr. W. D. Anderson, of Tuscaloosa; Vice-President, Dr. C. S. Stickley, of Montgomery; Secretary-Treasurer, Dr. J. A. Meadows, Jr., Medical Arts Bldg., Birmingham; Member of the Executive Committee, Dr. M. Eskridge, of Mobile; Counsellor to the American College of Radiology, Dr. John Day Peake, of Mobile.

ILLINOIS RADIOLOGICAL SOCIETY

The Illinois Radiological Society has recently elected to office Dr. Wm. DeHollander, Springfield, President; Dr. Gordon M. Perisho, Quincy, Vice-President; Dr. Stephen L. Casper, Physicians and Surgeons Clinic, Quincy, Secretary-Treasurer.

LOS ANGELES RADIOLOGICAL SOCIETY

The newly elected officers of the Los Angeles Radiological Society are: President, Harold P. Tompkins, M.D.; Vice-President, Richard Smith, M.D.; Secretary, John B. Hamilton, M.D., 210 North Central Ave., Glendale 3, Calif.; Treasurer, M. M. Haskell, M.D.

The Fourth Annual Mid-Winter Radiological Conference sponsored by the Society will be held at the Ambassador Hotel, Los Angeles, on Saturday and Sunday, Feb. 23 and 24. An informal banquet preceded by cocktails will be held at the Ambassador Hotel on Saturday evening, Feb. 23. Reservations for the meeting and banquet can be obtained by writing Roy W. Johnson, M.D., 1407 South Hope Street, Los Angeles 15, Calif.

The fee for the Conference is $20.00; for the banquet, $5.00. Non-radiological colleagues who may be interested in any of the meetings are invited to attend and should send in reservations.

The program follows:

Saturday Morning, Feb. 23

Roentgenological Examination of the Small Intestine, Kenneth Davis, M.D., Los Angeles
Possibilities and Limitations of Roentgen Diagnosis of Diseases of the Chest, Leo G. Rigler, M.D., Minneapolis, Minn.

Saturday Afternoon

Applications of Sectional Radiography, Wendell G. Scott, M.D., St. Louis, Mo.
Results of Treatment of Carcinoma of the Larynx, L. Henry Garland, M.D., San Francisco
Role of the Radiologist in Radiological Defense, Stafford L. Warren, M.D., Los Angeles

Sunday Morning, Feb. 24

Pitfalls in Contrast Myelography, John D. Camp, M.D., Los Angeles
Early Diagnosis of Cancer of the Stomach, Leo G. Rigler, M.D., Minneapolis, Minn.
Clinical Studies with Radioisotopes, John H. Lawrence, M.D., Berkeley, Calif.

Sunday Afternoon

Newer Cholecystopaques in Oral Cholecystography, Wendell G. Scott, M.D., St. Louis, Mo.
Roentgenologic Phrenology, or Roentgenologic Aspects of Tumors of the Scalp and Skull, John D. Camp, M.D., Los Angeles

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY

At a recent meeting of the Northeastern New York Radiological Society the following officers were elected: Dr. Orville Henderson, Troy, President; Dr. Joseph Rosenstein, Lake Placid, Vice-President; Dr. John Roach, Albany Hospital, Albany, Secretary-Treasurer.

WESTCHESTER (N. Y.) RADIOLOGICAL SOCIETY

A new radiological society has been added to those already active in New York State, the Westchester Radiological Society, with Dr. Walter J. Brown, Northern Westchester Hospital, Mt. Kisco, N. Y., as Secretary-Treasurer. The new society will meet four times a year, on the third Tuesday of January and October and on two other dates to be announced.

POSTGRADUATE COURSE ROENTGENOGRAPHIC INTERPRETATION DISEASES OF BONES AND JOINTS

In affiliation with the College of Physicians and Surgeons, Columbia University, there will be held at

the Hospital for Joint Diseases, New York, from March 5 through May 14, 1952, a postgraduate course in roentgenographic interpretation of diseases of the bones and joints. The course will consist of a series of lectures with lantern slide demonstrations representing material selected from cases seen at the Hospital for Joint Diseases in the past twenty-five years. At the same time there will be offered a postgraduate course in orthopedic surgery consisting of eleven morning and eleven afternoon sessions including lectures, conferences, case demonstrations, etc.

For information concerning either course, application should be made to Miss Amelia Mater, Hospital for Joint Diseases, 1919 Madison Ave., New York, N. Y.

TRAINING COURSES IN RADIOLOGICAL HEALTH

To assist health department personnel and key personnel in other governmental or private organizations in achieving a broader understanding of radiation hazards and problems, short training courses in radiological health are being offered without cost to qualified applicants by the Public Health Service at its Environmental Health Center in Cincinnati, Ohio. Basic courses are offered for Jan. 21–Feb. 1; March 10–March 21, and April 21–May 2, 1952. Intermediate courses, for those who have completed the equivalent of the basic curriculum, are scheduled for Feb. 4–15 and May 5–16.

Additional information concerning the curriculum and application procedure may be obtained from Chief, Radiological Health Training Section, Environmental Health Center, 1014 Broadway, Cincinnati 2, Ohio.

CONTINUATION COURSE X-RAY FOR GENERAL PHYSICIANS

The University of Minnesota will present a continuation course in X-Ray for General Physicians at the Center for Continuation Study on March 3 to 5, 1952. The course will be under the direction of Dr. Leo G. Rigler, Professor and Head of the Department of Radiology. Special emphasis will be placed on x-ray technics and x-ray diagnosis of fractures, other bone lesions, and pulmonary lesions. In addition to lectures on these subjects, practical demonstrations will be held. Registrants for the course will be invited to bring their own films for discussion.

CHANGE IN X-RAY PROTECTION HANDBOOK ANNOUNCED

Recent experimental work by the Radiation Laboratory of the National Bureau of Standards has shown that certain requirements governing the safe use of medical x-rays can be somewhat relaxed. Subcommittee 3 of the National Committee on Radiation Protection has therefore voted that the recommendation published in Section 7.1d of National Bureau of Standards Handbook 41, "Medical X-Ray Protection up to Two Million Volts," now reading "The aluminum equivalent of the table top shall not be more than 0.5 mm. at 80 kilovolts when a Bucky is used under the table top," be changed to "The aluminum equivalent of the table top shall not be more than 1.0 mm. when measured at 80 kilovolts without a patient or phantom."

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

THE 1951 YEAR BOOK OF RADIOLOGY (JUNE, 1950–JUNE, 1951). RADIOLOGIC DIAGNOSIS, edited by FRED JENNER HODGES, M.D., Professor and Chairman, Department of Roentgenology, University of Michigan, and JOHN FLOYD HOLT, M.D., Associate Professor, Department of Roentgenology, University of Michigan. RADIATION THERAPY, edited by HAROLD W. JACOX, M.D., Professor of Radiology, College of Physicians and Surgeons, Columbia University; Chief, Radiation Therapy Division, Radiologic Service, Presbyterian Hospital, New York City, and VINCENT P. COLLINS, M.D., Associate Professor of Radiology, College of Physicians and Surgeons, Columbia University, Director, Department of Radiation Therapy, Francis Delafield Hospital; Attending Radiologist, Presbyterian Hospital, New York City. A volume of 394 pages, with 368 illustrations. Published by the Year Book Publishers, Chicago 11, Ill., 1951. Price $7.00.

ROENTGEN EXAMINATIONS IN ACUTE ABDOMINAL DISEASES. By J. FRIMANN-DAHL, M.D., Ph.D., Chief of Roentgen Department, Ulleval Hospital, Oslo, Norway. A volume of 324 pages, with 305 figures. Published by Charles C Thomas, Springfield, Ill. Price $10.50.

ROENTGEN-DIAGNOSTICS. By H. R. SCHINZ, W. E. BAENSCH, E. FRIEDL, E. UEHLINGER. First American Edition (Based on the Fifth German Edition). English translation arranged and edited by JAMES T. CASE, M.D., D.M.R.E. Volume I, Skeleton (Part I), 868 pages, with 1,183 illustrations. Published by Grune & Stratton, New York, 1951.

DIE GESUNDE UND KRANKE WIRBELSÄULE IN RÖNTGENBILD UND KLINIK. PATHOLOGISCH-ANATOMISCHE UNTERSUCHUNGEN. By GEH. MED.-RAT PROF. DR. MED. ET DR. MED. VET. H.C. GEORG SCHMORL. Roentgen and clinical aspects revised

by PROF. DR. MED. HABIL. HERBERT JUNGHANNS, Oldenburg (Oldb.). A volume of 282 pages, with 399 illustrations. Second edition, published by Georg Thieme, Stuttgart, 1951. Distributors for U.S.A. and Canada: Grune & Stratton, Inc., 381 Fourth Ave., New York 16, N. Y.

KYMOGRAPHISCHE RÖNTGENDIAGNOSTIK. ZUR BEURTEILUNG DES HERZENS IN BEISPIELEN. By PROFESSOR DR. PLEIKART STUMPF, München. A monograph of 120 pages, with 164 figures. Published by Georg Thieme, Stuttgart, 1951. Distributors for U.S.A. and Canada: Grune & Stratton, Inc., 381 Fourth Ave., New York 16, N. Y.

MEDIZINISCHE RÖNTGENTECHNIK. LEHRBUCH FÜR MEDIZINISCH-TECHNISCHE ASSISTENTINNEN, STUDIERENDE UND ÄRZTE (in 2 Teilen). I. Medizinischer Teil (Skelettaufnahmen und Organuntersuchungen). Edited by PROF. DR. HERBERT SCHOEN, Leiter der Lehranstalt für medizinisch-technische Assistentinnen, Chefarzt des Zentralröntgeninstitutes an den Städt. Krankenanstalten Karlsruhe, with the collaboration of DIPL.-PHYSIKER ERICH BUNDE, Karlsruhe, DR. VIKTOR LOECK, Wuppertal-Elberfeld, and DR. WALTER FROMMHOLD, Karlsruhe. A volume of 228 pages, with 476 illustrations. Published by Georg Thieme, Stuttgart, 1951. Distributors for U.S.A. and Canada: Grune & Stratton, Inc., 381 Fourth Ave., New York 16, N. Y.

TOPOGRAPHISCHE AUSDEUTUNG DER BRONCHIEN IM RÖNTGENBILD, MIT BERÜCKSICHTIGUNG DER NEUZEITLICHEN NOMENKLATUR. Ergänzungsband 66, Fortschr. a. d. Geb. d. Röntgenstrahlen. By PRIV.-DOZ. DR. MED. CLAUS ESSER, Mainz. A volume of 152 pages, with 77 illustrations. Published by Georg Thieme, Stuttgart, 1951. Distributors for U.S.A. and Canada: Grune & Stratton, Inc., 381 Fourth Ave., New York 16, N. Y.

Book Reviews

RADIOLOGIC PHYSICS. By CHARLES WEYL AND S. REID WARREN, JR., Moore School of Electrical Engineering, University of Pennsylvania. With a Foreword by EUGENE P. PENDERGRASS, M.D., Director of the Department of Radiology, University of Pennsylvania. A volume of 492 pages, with numerous illustrations. Published by Charles C Thomas, Springfield, Ill., 2d ed., 1951. Price $10.50.

This is the second edition of a text which has had wide usage by radiologists and students during the past ten years. It has been completely rewritten and much new material has been added.

The material on electronics has been divided into two chapters, one on the principles of electronics, and one on the various electronic devices which are in general use. The chapters on artificial radioactivity have been expanded and clarified. The section on radiological protection has been rewritten to include new problems arising from the use of radioactive isotopes. The authors have also attempted to show the evolution of the various units of dosage so that the reader may have a background for understanding changes which may take place in the future.

The text is as understandable to the medical radiologist as such a treatise can be, proceeding from elementary physics to more advanced problems. It will serve the radiologist and student of radiology as a valuable source for study and reference.

RADIOACTIVITY APPLIED TO CHEMISTRY. ARTHUR C. WAHL, Editor, and NORMAN A. BONNER, Assistant Editor, both of Washington University, St. Louis. A volume of 604 pages. Published by John Wiley & Sons, Inc., New York, 1951. Price $7.50.

This book covers in a comprehensive manner the literature through 1949 on the applications of radioactivity to chemistry. As is pointed out in the Introduction, most of the applications of radioactivity to chemistry are based on two characteristics of radioactive atoms: (1) Before a radioactive atom decays, its chemical behavior is essentially the same as that of other atoms isotopic with it. (2) When a radioactive atom does decay, it emits energetic radiation that may be detected. Thus the fate of radioactive atoms in a chemical reaction may be determined by radioactivity measurements. It is upon this fact that the tracer technic, probably the most widely used application of radioactivity to chemistry, is based.

The first five chapters of the book deal with the tracer method as applied to isotopic exchange reactions, chemical kinetics, structural chemistry, self-diffusion studies, and analytical chemistry. Subsequent chapters cover the behavior of carrier-free tracers, radioactivity applied to the study of the newer elements, the chemical phenomena accompanying nuclear reactions (hot-atom chemistry), emanation methods, and radioactivity applied to surface determinations. These chapters constitute the first of the two main sections of the book, evaluating and discussing the various problems involved. The second section consists of a series of tables covering the principal data on the behavior of radiochemical systems.

Of particular interest to the radiologist are the observations on the chemical effects of radiation. The discussions of tracer technics and analytical technics and the data on tracer behavior and applications to chemical and physical problems should appeal especially to the research-minded clinician with an adequate chemical and physical background, the biophysicist, and the clinical chemist.

Well organized and cross referenced, this excellent book is a milestone in the literature of radioactivity and its relationship to chemistry.

AN ATLAS OF TUMOR PATHOLOGY. Published by the Armed Forces Institute of Pathology, under the auspices of the Subcommittee on Oncology of the Committee on Pathology of the National Research Council, Washington, D. C. For sale by the American Registry of Pathology, Washington 25, D. C.

INTRODUCTION AND TABLE OF CONTENTS. Fasc. I. By B. LUCKÉ, Professor of Pathology, University of Pennsylvania.

TUMORS OF THE PERIPHERAL NERVOUS SYSTEM. Section II, Fasc. 6. By ARTHUR PURDY STOUT, M.D., Professor of Surgery, Columbia University, College of Physicians and Surgeons, New York City. Fifty-eight pages, with 56 illustrations. Price $.60.

TUMORS OF THE MEDIASTINUM. Section V, Fasc. 8. By HANS GEORGE SCHLUMBERGER, M.D., Professor of Pathology, Ohio State University, College of Medicine, Columbus, Ohio. Eighty-eight pages, with 75 illustrations in black and white and 1 color plate. Price $.75.

TUMORS OF THE ADRENAL. Section VIII, Fasc. 29. By HOWARD T. KARSNER, M.D., Medical Research Advisor, Bureau of Medicine and Surgery, U. S. Navy, formerly Professor of Pathology, Western Reserve University. Sixty pages, with 47 illustrations in black and white and 5 color plates. Price $1.00.

TUMORS OF THE BREAST. Section IX Fasc. 34. By FRED W. STEWART, M.D., Pathologist to Memorial Hospital, Professor of Pathology, Cornell University Medical School, Attending Pathologist of New York Hospital, New York City. One hundred and fourteen pages, with 68 illustrations in black and white and 2 color plates. Price $1.10.

Five of thirty-four contemplated, loose-leaf fascicles comprising an atlas of tumor pathology are listed above. This ambitious and comprehensive undertaking has been supported and sponsored by the American Cancer Society, the Anna Fuller Fund, the Armed Forces Institute of Pathology, the Jane Coffin Childs Memorial Fund, the National Cancer Institute, and the U. S. Veterans Administration. It is a collaborative work representing the experience and opinions of extraordinarily skilled pathologists. As far as possible, a certain unity in presentation is adhered to. Designation and definition of the tumor are followed by an account of its natural history. The morphology, both gross and microscopic, is given pictorial representation and description, and the biologic attributes of the tumor are discussed. Differential criteria and a selected bibliography complete the presentation.

Such an undertaking shows good promise of partially satisfying the long-standing need for a modern "system of pathology" in English. The entire Atlas, fascicle by fascicle, will be distributed free of charge to laboratories of the Armed Forces and other government agencies. The fascicles may be obtained at cost by other interested readers through the American Registry of Pathology, Armed Forces Institute of Pathology, Washington, D. C.

DIAGNOSTIC ENCÉPHALOGRAPHIQUE. Encéphalogrammes normaux et pathologiques. Pathologie du liquide céphalique. By PIERRE DURAN, Médecin des hôpitaux militaires, Chef de Service de neuro-psychiatrie de l'Hôpital militaire d'instruction Desgenettes, with the collaboration of H. GARNUNG and R. COIRAULT, Médecins des hôpitaux militaires. A volume of 192 pages, with 26 figures. Published by G. Doin & Cie., Paris, 1951. Price 1,100 fr.

The procedure of encephalography has three objects in view: to render an anatomic diagnosis on the state of the intracranial contents, to remove spinal fluid for diagnostic procedures, and to treat certain neuropsychiatric affections. The author of this monograph has divided his material into six chapters. The first chapter is of a general nature and is devoted to the technic of encephalography, along with complications and contraindications. In the second, the normal encephalogram is discussed, and in the third the pathologic encephalogram. A comparative study of the chemical, immunological, and cytological aspects of the spinal fluid constitutes the fourth chapter. The fifth is devoted to the medicolegal aspects of encephalography and the sixth to its therapeutic application. Most of the material is not presented as anything new but rather as representing the experience of the author. The chapter on the therapeutic value of pneumoencephalography may be of interest to those in the United States who have had relatively little experience in this direction. The method is not a certain cure for any known condition, but occasional instances of definite amelioration of symptoms have been noted in patients with post-traumatic sequelae, essential and post-traumatic epilepsy, sequelae of infantile encephalopathies, certain mental conditions, and such rare disorders as diabetes insipidus or obesity dependent on involvement of the hypothalmus.

IN MEMORIAM

R. BRUCE MACDUFF, M.D.

1892–1951

Dr. Robert Bruce Macduff of Flint, Mich., died of a cerebral hemorrhage on Oct. 28, 1951, at the age of fifty-nine.

Dr. Macduff was born in Flint in 1892, son of Rev. Ralph E. Macduff. After premedical preparation at the University of Chicago, he was graduated in medicine from the University of Michigan in 1917. Following service in World War I and a short experience in general practice, he devoted two years to postgraduate study in Ann Arbor, and in 1923 returned to Flint to specialize in roentgenology. From 1927 to 1932 he served as chief of the radiological department at Hurley Hospital.

For twenty-five years Bruce Macduff worked untiringly for the building of a new and larger Women's Hospital in Flint. Happily he lived to see the accomplishment of his goal. The new hospital—named the McLaren General in honor of a much loved superintendent whose efforts had paralleled his own—was dedicated in the fall of 1951. Dr. Macduff was vice-chairman of the Medical Board and was to have moved into his new office as chief radiologist the day following his death.

Dr. Macduff was a member of the Genesee County Medical Society, of which he was at one time secretary, of the Michigan State Medical Society, and of the Radiological Society of North America. He had been for a number of years secretary-treasurer of the Michigan Association of Roentgenologists. He is survived by his wife, Ellen J., and a daughter, Ellen Gray, of Flint.

R. BRUCE MACDUFF, M.D.

The private practice of radiology with its daily routine is not glamorous, nor is it conducive to extensive contributions to the scientific literature. It does, however, offer a contact with patients that in the case of a man with Dr. Macduff's charm of personality and warm sympathy leads to rewarding friendships. That many chose to contribute to a permanent memorial in his honor, in the new hospital, rather than offer the usual perishable floral tributes, is a testimony to the high regard in which he was held.

"We are such stuff
As dreams are made on; and our little life
Is rounded with a sleep."

HORACE W. PORTER, M.D.

RAPHAEL POMERANZ, M.D.

1895–1951

Dr. Raphael Pomeranz, a native of Poland but long active in radiology in this country, died in August 1951. He received his medical education at the University of Vienna and in the Roentgenologic Institute of Professor Holzknecht. Coming to America some thirty years ago, he interned at the Newark City Hospital, passed the New Jersey State Medical Board examination in 1924, and the following year opened an office for the practice of radiology in Newark. He became a diplomate of the American Board of Radiology in 1935. During the Second World War he saw service with the rank of Major.

Dr. Pomeranz held many positions in the Newark area, including those of Roentgenologist at the Newark City Hospital, Chief of Roentgenology and Vice-President of the Medical Board of the Crippled Children's Hospital, Associate in Roentgenology at Beth Israel Hospital, and Roentgenologist at the American Legion Hospital. He was a member of the Radiological Society of New Jersey, which he served as president in 1950, of the Essex County and New Jersey Medical Societies, the American

Medical Association, the Radiological Society of North America, the American College of Radiology, and the International College of Surgeons. He held membership in Composite Lodge No. 223 of the Free and Accepted Masons.

Dr. Pomeranz was an accomplished musician and owned a large collection of symphonic music. He had made for himself an important place in both medical and non-medical circles and will be greatly missed. His wife, Zina, and his children, Jerome and Helen, survive him.

CARYE-BELLE HENLE, M.D.

LOUIS A. MILKMAN, M.D.

1895–1951

Dr. Louis A. Milkman, whose name is familiar to all radiologists in connection with Milkman's syndrome, died after a short illness on Oct. 25, 1951.

Dr. Milkman was born in North Scranton, Penna., was graduated from St. Thomas College, received his medical degree from Temple University in 1919, served his internship in the Philadelphia General Hospital, and did postgraduate work in roentgenology at the New York Post-Graduate Hospital and Medical School under Dr. William Meyer. He served for some time as clinical assistant in radiology and later as associate professor in the Post-Graduate Medical School and for ten years was instructor in physics at St. Thomas College.

Dr. Milkman was for sixteen years director of the State Hospital at Scranton, and was consulting radiologist of that institution from the time of his resignation from the active directorship in 1942 until his death. He served also, at various times, as director of the x-ray department of St. Mary's, St. Joseph's, and General Hospital, Carbondale, Penna., and Mercy Hospital, Scranton. He was for fifteen years roentgenologist for the Pennsylvania Workmen's Compensation Board and was recognized as an authority on anthracosilicosis. His report of a case of Multiple Idiopathic Symmetrical Fractures, demonstrable roentgenographically as bands or zones of increased transparency throughout the involved bone, was published in 1934 (Am. J. Roentgenol. **32**: 622, 1934) and his name was soon identified with the condition.

Dr. Milkman was a fellow of the American College of Physicians, the American College of Radiology, and the American Medical Association. He was a member of the Radiological Society of North America and of the Pennsylvania Radiological Society, of which he was president in 1938. He was a past vice-president of St. Thomas College Alumni Association and until his death was active in the affairs of the Temple University Alumni Association. He was a veteran of World War I and a member of the Davis-Wainwright-Gibbons Post 187, American Legion.

In addition to his interest in his specialty, Dr. Milkman was widely read in related sciences, history, and biography, and his opinions were held in high regard. He is survived by his wife, a son who is a student at Harvard Medical School, and by his father.

RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

Editor's Note: Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates.

RADIOLOGICAL SOCIETY OF NORTH AMERICA. *Secretary-Treasurer*, Donald S. Childs, M.D., 713 E. Genesee St., Syracuse 2, N. Y.

AMERICAN RADIUM SOCIETY. *Secretary*, John E. Wirth, M.D., 635 Herkimer St., Pasadena 1, Calif.

AMERICAN ROENTGEN RAY SOCIETY. *Secretary*, Barton R. Young, M.D., Germantown Hospital, Philadelphia 44, Penna.

AMERICAN COLLEGE OF RADIOLOGY. *Exec. Secretary*, William C. Stronach, 20 N. Wacker Dr., Chicago 6.

SECTION ON RADIOLOGY, A. M. A. *Secretary*, Paul C. Hodges, M.D., 950 East 59th St., Chicago.

Alabama

ALABAMA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. A. Meadows, Jr., M.D., Medical Arts Bldg., Birmingham 5.

Arizona

ARIZONA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. Lee Foster, M.D., 507 Professional Bldg., Phoenix. Annual meeting with State Medical Association.

Arkansas

ARKANSAS RADIOLOGICAL SOCIETY. *Secretary*, Fred Hames, M.D., Pine Bluff. Meets every three months and at meeting of State Medical Society.

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY. *Secretary*, Sydney F. Thomas, M.D., Palo Alto Clinic, Palo Alto.

EAST BAY ROENTGEN SOCIETY. *Secretary*, Dan Tucker, M.D., 434 30th St., Oakland 9. Meets monthly, first Thursday, at Peralta Hospital.

LOS ANGELES RADIOLOGICAL SOCIETY. *Secretary*, John B. Hamilton, M.D., 210 N. Central Ave., Glendale 3. Meets monthly, second Wednesday, Los Angeles County Medical Association Bldg.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB. *Secretary*, G. A. Fricker, Sacramento Co. Hospital, Sacramento 17. Meets at dinner last Monday of September, November, January, March, and May.

PACIFIC ROENTGEN SOCIETY. *Secretary*, L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually with State Medical Association.

SAN DIEGO ROENTGEN SOCIETY. *Secretary*, R. F. Niehaus, M.D., 1831 Fourth Ave., San Diego. Meets first Wednesday of each month.

SAN FRANCISCO RADIOLOGICAL SOCIETY. *Secretary*, I. J. Miller, M.D., 2680 Ocean Ave., San Francisco 27. Meets quarterly.

SOUTH BAY RADIOLOGICAL SOCIETY. *Secretary*, Ford Shepherd, M.D., 526 Soquel Ave., Santa Cruz. Meets monthly, second Wednesday.

X-RAY STUDY CLUB OF SAN FRANCISCO. *Secretary*, Merrell A. Sisson, M.D., 450 Sutter St., San Francisco 8. Meets third Thursday at 7:45 January to June at Stanford University Hospital, July to December at San Francisco Hospital.

Colorado

COLORADO RADIOLOGICAL SOCIETY. *Secretary*, Wendell P. Stampfli, M.D., 1933 Pearl St., Denver. Meets monthly, third Friday, at University of Colorado Medical Center or Denver Athletic Club.

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, Fred Zaff, M.D., 135 Whitney Ave., New Haven. Meets bimonthly, second Wednesday.

CONNECTICUT VALLEY RADIOLOGICAL SOCIETY. *Secretary*, Ellwood W. Godfrey, M.D., 1676 Boulevard, W. Hartford. Meets second Friday of October and April.

District of Columbia

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY. *Secretary*, U. V. Wilcox, M.D., 915 19th St., N.W., Washington 6. Meets third Thursday, January, March, May, and October, at 8:00 P.M., in Medical Society Library.

Florida

FLORIDA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Nelson T. Pearson, M.D., 1109 Huntington Bldg., Miami. Meets in April and in November.

GREATER MIAMI RADIOLOGICAL SOCIETY. *Secretary*, Maurice Greenfield, M.D., Ingraham Bldg., Miami. Meets monthly, third Wednesday, 8:00 P.M., Veterans Administration Bldg., Miami.

Georgia

ATLANTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Dudley King, M.D., 35 Linden Ave., N. E. Meets second Friday, September to May.

GEORGIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Robert C. Pendergrass, M.D., Americus. Meets in November and at the annual meeting of the State Medical Association.

RICHMOND COUNTY RADIOLOGICAL SOCIETY. *Secretary*, Wm. F. Hamilton, Jr., M.D., University Hospital, Augusta.

Illinois

CHICAGO ROENTGEN SOCIETY. *Secretary*, Benjamin D. Braun, M.D., 6 N. Michigan Ave., Chicago 11. Meets at the University Club, second Thursday of October, November, January, February, March, and April at 8:00 P.M.

ILLINOIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Stephen L. Casper, M.D., Physicians and Surgeons Clinic, Quincy.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, Willard C. Smullen, M.D., St. Mary's Hospital, Decatur.

Indiana

INDIANA ROENTGEN SOCIETY. *Secretary-Treasurer*, William M. Loehr, M.D., 712 Hume-Mansur Bldg., Indianapolis 4. Annual meeting in May.

Iowa

IOWA X-RAY CLUB. *Secretary*, Arthur W. Erskine, M.D., 326 Higley Building, Cedar Rapids. Meets during annual session of State Medical Society.

Kansas

KANSAS RADIOLOGICAL SOCIETY. *Secretary*, Charles M. White, M.D., 3244 East Douglas, Wichita 8. Meets annually with State Medical Society.

Kentucky

KENTUCKY RADIOLOGICAL SOCIETY. *Secretary*, Everett L. Pirkey, M.D., Louisville General Hospital. Meets monthly, second Friday, at Seelbach Hotel, Louisville.

Louisiana

LOUISIANA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Johnson R. Anderson, M.D., No. Louisiana Sanitarium, Shreveport. Meets with State Medical Society.

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary*, Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets first Tuesday of each month.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary*, Oscar O. Jones, M.D., 2622 Greenwood Road. Meets monthly September to May, third Wednesday.

Maine

MAINE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Clark F. Miller, M.D., Central Maine General Hospital, Lewiston.

Maryland

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION. *Secretary-Treasurer*, Richard B. Hanchett, M.D., 705-6, Medical Arts Bldg., Baltimore 1. Meets third Tuesday, September to May.

Michigan

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary*, James C. Cook, M.D., Harper Hospital, Detroit 1. Meets first Thursday, October to May, at Wayne County Medical Society club rooms.

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary*, Leo A. Nash, M.D., 572 Lowry Medical Arts Bldg., St. Paul 2. Meets in Spring and Fall.

Mississippi

MISSISSIPPI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John W. Evans, M.D., 621 High St., Jackson 2, Miss. Meets monthly, third Tuesday, at 6:30 P.M., at the Rotisserie Restaurant, Jackson.

Missouri

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. *Secretary*, Wm. M. Kitchen, M.D., 1010 Rialto Building, Kansas City 6, Mo. Meets last Friday of each month.

ST. LOUIS SOCIETY OF RADIOLOGISTS. *Secretary*, Donald S. Bottom, M.D., 510 S. Kingshighway Blvd. Meets on fourth Wednesday, October to May.

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Russell W. Blanchard, M.D., 1216 Medical Arts Bldg., Omaha. Meets fourth Thursday of each month at 6 P.M. in Omaha or Lincoln.

New England

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary*, L. L. Robbins, M.D., Massachusetts General Hospital, Boston 14. Meets monthly on third Friday, at the Harvard Club, Boston.

New Hampshire

NEW HAMPSHIRE ROENTGEN SOCIETY. *Secretary*, Albert C. Johnston, M.D., Elliot Community Hospital, Keene. Meets quarterly in Concord.

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary*, Nicholas G. Demy, M.D., 912 Prospect Ave., Plainfield. Meets at Atlantic City at time of State Medical Society and midwinter in Elizabeth.

New York

ASSOCIATED RADIOLOGISTS OF NEW YORK, INC. *Secretary*, William J. Francis, M.D., East Rockaway.

BROOKLYN ROENTGEN RAY SOCIETY. *Secretary*, J. Daversa, M.D., 603 Fourth Ave., Brooklyn. Meets fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Mario C. Gian, M.D., 610 Niagara St., Buffalo 1. Meets second Monday, October to May.

CENTRAL NEW YORK ROENTGEN SOCIETY. *Secretary*, Dwight V. Needham, M.D., 608 E. Genesee St., Syracuse 10. Meets in January, May, October.

KINGS COUNTY RADIOLOGICAL SOCIETY. *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meets fourth Thursday, October to May, at 8:45 P.M., Kings County Medical Bldg.

NEW YORK ROENTGEN SOCIETY. *Secretary*, Irving Schwartz, M.D., 45 E. 66th St., New York 21.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John F. Roach, M.D., Albany Hospital, Albany. Meets at University Club, Albany, second Wednesday, October, November, and March. Annual meeting in June.

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary-Treasurer*, George Gamsu, M.D., 191 S. Goodman St. Meets at Strong Memorial Hospital, last Monday of each month, September through May.

WESTCHESTER RADIOLOGICAL SOCIETY. *Secretary*, Walter J. Brown, M.D., Northern Westchester Hospital, Mount Kisco, N. Y. Meets third Tuesday of January and October and at other times as announced.

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary*, James E. Hemphill, M.D., Professional Bldg., Charlotte 2. Meets in May and October.

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary*, P. H. Woutat, M.D., 322 Demers Ave., Grand Forks.

Ohio

OHIO STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Willis S. Peck, M.D., 2001 Collingwood Ave., Toledo. Meets with State Medical Association.

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary*, Frank A. Riebel, M.D., 15 W. Goodale St., Columbus. Meets second Thursday, October, December, February, April, and June, 6:30 P.M., Columbus Athletic Club, Columbus.

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Mortimer Lubert, M.D., Heights Medical Center Bldg., Cleveland Heights 6. Meets at 6:45 P.M. on fourth Monday, October to April, inclusive.

GREATER CINCINNATI RADIOLOGICAL SOCIETY. *Secretary*, Lee S. Rosenberg, M.D., Jewish Hospital, Cincinnati 29. Meets first Monday, October through May.

MIAMI VALLEY RADIOLOGICAL SOCIETY. *Secretary*, Geo. A. Nicoll, M.D., Miami Valley Hospital, Dayton. Meets monthly, second Friday.

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. E. Brown, M.D., 21st and Xanthus, Tulsa 4. Meets in October, January, and May.

Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Richard Raines, M.D., Medical-Dental Bldg., Portland 5. Meets monthly, second Wednesday, October to June, at 8:00 P.M., University Club.

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Sydney J. Hawley, M.D., 1320 Madison St., Seattle 4. Meets annually in May.

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James M. Converse, M.D., 416 Pine St., Williamsport 8. Meets annually.

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary*, George P. Keefer, M.D., American Oncologic Hospital, Philadelphia 4. Meets first Thursday of each month at 8:00 P.M., from October to May, in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY. *Secretary-Treasurer*, Edwin J. Euphrat, M.D., 3500 Fifth Ave., Pittsburgh 13. Meets monthly, second Wednesday, at 6:30 P.M., October to May, at Webster Hall.

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Maurice D. Frazer, M.D., 1037 Stuart Bldg., Lincoln, Nebr.

South Carolina

SOUTH CAROLINA X-RAY SOCIETY. *Secretary-Treasurer*, Henry E. Plenge, M.D., 855 N. Church St., Spartanburg. Meets with State Medical Association in May.

South Dakota

RADIOLOGICAL SOCIETY OF SOUTH DAKOTA. *Secretary-Treasurer*, Marianne Wallis, M.D., 1200 E. Fifth Ave., Mitchell. Meets during annual meeting of State Medical Society.

Tennessee

MEMPHIS ROENTGEN CLUB. *Secretary*, John E. Whiteleather, M.D., 899 Madison Ave. Meets first Monday of each month at John Gaston Hospital.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meets annually with State Medical Society in April.

Texas

DALLAS-FORT WORTH ROENTGEN STUDY CLUB. Meets monthly, third Monday, in Dallas odd months, Fort Worth even months.

HOUSTON RADIOLOGICAL SOCIETY. *Secretary*, Frank M. Windrow, M.D., 1205 Hermann Professional Bldg.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. P. O'Bannon, M.D., 650 Fifth Ave., Fort Worth.

Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Angus K. Wilson, M.D., 343 S. Main St., Salt Lake City. Meets third Wednesday, January, March, May, September, November.

Virginia

VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, P. B. Parsons, M.D., Norfolk General Hospital, Norfolk.

Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. C. Kiltz, M.D., 705 Medical-Dental Bldg., Everett. Meets fourth Monday, October through May, at College Club, Seattle.

Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Theodore J. Pfeffer, M.D., 839 N. Marshall St., Milwaukee 2. Meets monthly on second Monday at the University Club.

RADIOLOGICAL SECTION OF THE WISCONSIN STATE MEDICAL SOCIETY. *Secretary*, Abraham Melamed, M.D., 425 E. Wisconsin Ave., Milwaukee. Meets in May and with State Medical Society, September.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE. Meets first and third Thursday at 4 P.M., September to May, Service Memorial Institute.

WISCONSIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Irving I. Cowan, M.D., 425 East Wisconsin Ave., Milwaukee 2.

CANADA

CANADIAN ASSOCIATION OF RADIOLOGISTS. *Honorary Secretary-Treasurer*, Jean Bouchard, M.D. Assoc. Hon. Secretary-Treasurer, D. L. McRae, M.D. *Central Office*, 1555 Summerhill Ave., Montreal 26, Quebec. Meets in January and June.

LA SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES. *General Secretary*, Origène Dufresne, M.D., Institut du Radium, Montreal. Meets third Saturday each month.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPÍA DE CUBA. Offices in Hospital Mercedes, Havana. Meets monthly.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGÍA Y FISIOTERAPÍA. *General Secretary*, Dr. Dionisio Pérez Cosío, Marsella 11, Mexico, D.F. Meets first Monday of each month.

PANAMA

SOCIEDAD RADIOLÓGICA PANAMEÑA. *Secretary-Editor*, Luis Arrieta Sánchez, M.D., Apartado No. 86, Panama, R. de P.

PUERTO RICO

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA. *Secretary*, Jesús Rivera Otero, M.D., Box 3542 Santurce, Puerto Rico.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

The Chest

The Digestive System

The Musculoskeletal System

Gynecology and Obstetrics

The Genito-Urinary System

Blood Vessels; Lymphatics

Technic; Contrast Media

RADIOTHERAPY

RADIOISOTOPES

EFFECTS OF RADIATION

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Cerebral Angiography. Frank H. Mayfield, Edgar S. Lotspeich, Jr., James R. Simpson, and Curwood R. Hunter. Ohio State M.J. **47**: 134–137, February 1951.

The most common indication for cerebral angiography is found in patients who have suffered spontaneous subarachnoid hemorrhage and hence are suspected of having intracranial aneurysms. It is also of diagnostic aid in the study of vascular tumors and malformations, which may not deform the ventricular system and are not demonstrable by pneumoencephalography or by ventriculography. Arteriovenous fistulae, vascular occlusions, and post-traumatic lesions may also be demonstrated. In cases of brain tumor in which it is impossible to obtain adequate air studies angiograms may establish the diagnosis without disturbing the intracranial dynamics.

The dye, usually diodrast, occasionally thorotrast, may be introduced into the common carotid or the internal carotid artery by percutaneous injection, or the vessel may be exposed surgically. Injection into the carotids affords visualization of the intracranial portion of the internal carotid artery, the anterior portion of the circle of Willis, and the anterior and middle cerebral arteries. The venous channels of the skull are also demonstrated. The posterior portion of the circle of Willis and its branches are seen following injection of the vertebral artery.

Co-ordination between the surgeon and radiologist is essential in cerebral angiography, since the radiographic exposures are made as rapidly as possible, while the dye is being injected, usually at intervals of one to three seconds, until three exposures have been obtained. One can usually visualize the entire arterial tree with the first exposure. With the subsequent exposures the venous system is seen.

Eleven roentgenograms.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Some Examples of the Diagnostic Value of Percutaneous Carotid Angiography. Knut Koppang. Acta radiol. **35**: 137–145, February-March 1951.

Cerebral angiography has supplemented and in some respects replaced pneumographic examination. Not only does this newer method aid in localization of pathological processes but it has proved especially valuable in suggesting the type of lesion present.

At Rikshospitalet, Oslo, from which this communication comes, percutaneous puncture of the common carotid artery is employed. The relative simplicity of the procedure is indicated by 354 satisfactory examinations performed by a single examiner in 359 cases.

Three cases demonstrating the diagnostic value of cerebral angiography are presented. In the first case, there was occlusion of the internal carotid artery on one side. Injection of the contralateral carotid artery revealed bilateral filling of the carotids, indicating establishment of a collateral circulation *via* the circle of Willis.

The second case was that of a 60-year-old male with a chronic discharge from the left ear. The patient was somnolent, partially unconscious and delirious and cerebral complications secondary to the ear infection were suspected. Operation, however, failed to show extension of the inflammatory process beyond the middle ear. Angiograms revealed displacement of the left anterior cerebral artery to the same side and an increased distance from the right cranial wall to the right middle cerebral artery. An extracerebral hematoma on the right was demonstrated.

In the third case, that of a mentally undeveloped five-year-old girl, marked dislocation of the frontoparietal vessels was seen. Operation disclosed bilateral hygromas. This case demonstrates the usefulness of percutaneous angiography even in small children.

Ten roentgenograms.

MILTON SEGAL, M.D.
Cleveland City Hospital

Angiographical Diagnosis of Carotid Body Tumours. Hans Idbohrn. Acta radiol. **35**: 115–123, February-March 1951.

The carotid body is located at the bifurcation of the common carotid artery, just behind the latter or medially behind the caudal part of the internal carotid artery. Its blood supply is from the external carotid artery.

Carotid body tumors are generally solid, slow-growing, round or ovoid, with smooth or granular surfaces. They may grow around and embed the external, internal or the common carotid artery.

Although the tumor may itself be asymptomatic, it may produce symptoms of pressure on the adjacent vagus or sympathetic nervous system. Carotid sinus symptoms, as drowsiness, giddiness, faintness, and loss of consciousness, are unusual in view of the intimate topographical relationship.

Surgical removal is the treatment of choice since these tumors are radioresistant. Excision of the tumor may not be technically feasible and the common carotid artery or one of the main branches may have to be ligated.

Due to the rich vascularity of the tumor, it is readily visualized by angiography. Ten cubic centimeters of 35 per cent umbradil are injected rapidly into the common carotid artery. Two exposures are taken, one immediately after the injection and the other two seconds later. The highly vascular tumor mass widens the bifurcation of the carotid arteries and the common carotid artery becomes dilated, as observed in the 3 cases reported.

Three roentgenograms; 1 photograph.

SHOZO IBA, M.D.
Cleveland City Hospital

Vertebral Angiography by Catheterization. A New Method Employed in 221 Cases. Stig Radner. Acta radiol., Suppl. 87, 1951.

Various technics which have been used for vertebral angiography are described. Only the upper percutaneous route in which the second portion of the vertebral artery was punctured has been conclusively shown to produce good results. In the technic described by the author, the right radial artery is exposed and a French size 5 or 6 ureteral catheter is threaded into the artery. A special three-way tube permits the catheter, a guide wire, heparin infusion and the contrast medium to be used singly or in combination. The catheter, con-

taining the guide wire, is inserted through the arteries of the arm and into the subclavian artery and, with the aid of fluoroscopy, is directed into the right vertebral artery. The guide wire and external manipulation facilitate proper placement.

Catheterization is first attempted on the right side in all cases, the left side being used only in the event of right-sided failure. The regional arterial anatomy is carefully outlined in the monograph. Preoperative preparation includes sedation and the use of papaverin hydrochloride to avoid arterial spasm.

The contrast medium, a 35 per cent solution of umbradil (3:5-diiodo-4-pyridone-N-acetic acid), is injected within two to three seconds. Each injection uses a volume of 8 to 10 c.c. A total of 40 c.c. is not exceeded. All patients are tested for sensitivity to iodine. Films are taken in the lateral, fronto-occipital, and basilar projections.

Catheterization was attempted in 221 cases; the vertebral artery was entered in 203 cases; angiography was actually performed in 200 cases. Occipital pain was a usual reaction. Nausea and vomiting occurred in 23 cases, and transient weakness and numbness in 2 cases. Two patients died, eleven and fourteen days after angiography. Autopsy in these cases showed old softening in the region supplied by the vertebral artery. Bilateral filling of the vertebral arteries following unilateral injection occurred in 69 cases.

Review of the cases shows a wide range of variation in the craniovascular relationships in vertebral angiography so that vascular displacement is difficult to evaluate. Arteriovenous and saccular aneurysms are disclosed. Irregularities in the walls of arteriosclerotic vessels can be demonstrated. Pronounced internal hydrocephalus produces stretching of the vessels, evidenced by loss of the normal tortuous course of the arteries. Cerebellar astrocytomas and medulloblastomas also show stretching of the vessels consequent to secondary hydrocephalus. In cerebellar hemangioblastoma a mural nodule is demonstrable. Vascular displacement and a pathological network of vessels may be seen in acoustic neurinoma and subtentorial meningioma. Pineal tumors show pathologic vasculature and stretching of the vessels. Occipito-temporal tumors within direct range of the vertebral system produce changes similar to those demonstrated by carotid angiography. Supratentorial tumors indirectly related to the vertebral arterial system may depress the vessels in the region of the incisura tentorii.

One hundred and three roentgenograms; 10 photographs; 5 figures; 3 tables.

RICHARD F. MCCLURE, M.D.
The Henry Ford Hospital

Importance of Congenital Toxoplasma Infection for the Etiologic X-Ray Diagnosis of Organic Defects of the Central Nervous System. Johannes Schoeps. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 101–104, January 1951. (In German)

The author discusses the importance of congenital toxoplasmosis in the etiology of organic diseases of the central nervous system, especially with regard to various physiopsychic defects. The knowledge of the parasitologic and serologic reaction in human toxoplasmosis, with its trend toward spontaneous healing of any defect inside the encephalon, the early disappearance of the microorganisms from the cerebrospinal fluid, as well as gradual subsidence of positive antibody reactions, have proved the superiority of x-ray examinations of the central nervous system in the elucidation of many psychomotor and purely somatic defects. Bilateral intracranial calcium incrustations with or without simultaneous hydrocephalus raise roentgenologically the suspicion of toxoplasmosis. Congenital malformations may also be of toxoplasmogenic origin.

ERNST A. SCHMIDT, M.D.
Denver, Colo.

Use of Tomography in Diagnosis of Basilar Impression. Vladimir Gvozdanović and Sergije Dogan. Acta radiol. **35**: 124–132, February-March 1951.

Basilar impression is a deformity of the skull in which the upper cervical spine is pushed up into the base of the skull. This or similar deformations have been variously termed basilar invagination, convexo-basia, and platybasia. The majority of cases are of congenital origin, though neurological symptoms do not appear until late in life.

A definite diagnosis can only be made roentgenologically. A lateral view of the skull shows (1) apparent constriction of the nasopharynx due to the high position of the cervical spine, (2) cranio-convex configuration of the basio-occiput, and (3) a high circular shadow of petrous bone. In the anteroposterior view one sees (1) an increased distance between the petrosal ridge and the lowermost part of the occipital squama, (2) projection of the atlas and axis into the upper part of the maxillary sinus, and (3) a cranio-convex line representing the base of the skull, projecting into the sphenoidal sinus and extending inferiorly and laterally over the pyramids.

Chamberlain's line, a line drawn from the posterior edge of the hard palate to the posterior edge of the foramen magnum is the most reliable criterion of the degree of basilar impression. Bull's angle and Welcher's basal angle for measuring basilar impression are also described.

The authors have adopted the tomographic technic for demonstration of this condition. Tomograms made in the lateral projection show the position of the top of the odontoid process in relation to Chamberlain's line, the defects, hypoplasia, or "splittering" of the posterior arch of the atlas, as well as the possible deformity of the odontoid process and its position in the foramen magnum. In the anteroposterior position the changes of the atlanto-occipital joints can be seen.

The findings in 3 cases of basilar impression are presented.

Five roentgenograms.

SHOZO IBA, M.D.
Cleveland City Hospital

Osteoporosis Circumscripta Cranii. G. E. Vilvandré. Proc. Roy. Soc. Med. **44**: 154, February 1951.

Radiological examination of the skull of a woman of 65 with palpable bosses over the occipitoparietal sutures showed marked loss of density due to osteoporosis in confluent and extensive distribution—osteoporosis circumscripta cranii. A pelvic film showed definite Paget's disease. No evidence of hyperparathyroidism was obtainable.

While osteoporosis of this type is more often associated with Paget's disease, it has also been reported in patients with hyperparathyroidism. The author is strongly tempted to believe that "osteoporosis circumscripta cranii, associated with Paget's disease and

hyperparathyroidism, suggests that the former is also due to some ductless gland deterioration or failure."

Two roentgenograms.

The Pterygo-Alar Bar and Its Recognition by Roentgen Methods in Trigeminal Neuralgia. Kehar S. Chouké and Philip J. Hodes. Am. J. Roentgenol. **65**: 180–182, February 1951.

This is a concise discussion of an anatomical variation—the pterygo-alar bar—occurring in about 7 per cent of the general population. Anatomically this is probably an ossified pterygo-alar ligament. It may exist as a bony ridge or may help form an additional foramen lying along the lateral margin of the foramen ovale. Roentgenographically it is represented by a zone of increased bone density intimately connected with the lateral margin of the foramen ovale. It is probably best observed in the ordinary base view of the skull (mento-coronal).

Clinically, the anomaly may be of significance as an obstacle to the injecting needle inserted through a lateral route in an attempt to inject the trigeminal nerve.

The six film reproductions in this article are extremely good.

GEORGE REGNIER, M.D.
University of Arkansas

Calcareous Cataract in the X-Ray Picture. E. Vogler. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 87–91, January 1951. (In German)

Four cases of calcareous cataract are presented in which the roentgenograms showed typical and well defined calcifications within the orbit. Three of these cases were due to trauma, one to inflammation. In the differential diagnosis calcifications of the choroid or vitreous, calcific deposits in tumors, and calcified parasites, Cysticercus or Echinococcus, are to be excluded.

Eight roentgenograms. ERNST A. SCHMIDT, M.D.
Denver, Colo.

Unilateral Pansinal Mucocele Simulating a Malignant Neoplasm. Report of a Case. Walter P. Anthony and Henry L. Williams. Arch. Otolaryng. **53**: 189–194, February 1951.

A 38-year-old female complained of a cutting pain over the left eye and temple and failing vision in the left eye. Examination revealed a firm, elastic, fixed mass in the left nasal cavity. Roentgenograms of the skull were interpreted as showing extensive malignant destruction of the floor of the sella turcica and the dorsum sellae and the body of the sphenoid bone; destruction of the tips of both petrous processes, more marked on the left; extensive destruction of both ethmoid areas and the medial wall of the left orbit; opacity of both antra, and a mass in the left side of the nose. A presumptive diagnosis of inoperable malignant neoplasm was made and roentgen therapy was given.

The patient returned a year later with little change in the physical findings. Roentgenograms of the skull, however, showed some decrease in the area of destruction. Because of the apparently benign behavior of the lesion, an exploratory operation was done. A mass of gummy, rubbery mucus was found in the ethmoid and sphenoid sinuses, causing marked erosion. This was removed. The left antrum was then opened and found to be filled with the same type of material. The pathologic report on the tissue removed was inflammatory mucous membrane, with dilated mucous glands and inspissated mucus. The patient made a satisfactory recovery.

This case is held to indicate that true mucoceles of the texture of those found in the ethmoids and frontal sinuses may occur in the maxillary sinus. Mucoceles of the sphenoid sinus, although rare, may develop and expand rapidly, producing extensive destruction of bone simulating that due to a malignant neoplasm. These observations must be considered in differential diagnosis.

Three roentgenograms; 1 photograph.

PAUL W. ROMAN, M.D.
Baltimore, Md.

The Function Test in the Early X-Ray Diagnosis of Diseases of the Mandibular Joint. H. Weingraber. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 84–86, January 1951. (In German)

In early stages of disease of the mandibular joint when no x-ray evidence of bone involvement can be demonstrated by ordinary radiography, reduced extent of the movement of the condyloid process may provide an early diagnosis. This limitation of motion may be regarded as pathognomonic of arthrosclerosis as yet confined to the soft tissues of the joint. For the visualization of finer details in the affected articulation, tomography is especially valuable.

Fourteen roentgenograms.

ERNST A. SCHMIDT, M.D.
Denver, Colo.

THE CHEST

Transverse Tomogram of the Normal Thorax; A Contribution to Topographical Anatomy in the Living Man. Alfred Gebauer. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 14–23, January 1951. (In German)

Transverse body-section films of a normal subject vary considerably in appearance, dependent on the level of visualization. The author has selected four areas within which similar views may be obtained and compared: the diaphragmatic area (from the first lumbar vertebra to the tenth thoracic vertebra); second, the diaphragmatic hilar area (from the tenth to the eighth thoracic vertebra); third, the hilar area (from the eighth to the fifth thoracic vertebra); and finally the apical area (from the fifth to the first thoracic vertebra). Typical anatomical details of each area are shown and demonstrated in the roentgenograms.

Nineteen roentgenograms; 6 drawings.

ERNST A. SCHMIDT, M.D.
Denver, Colo.

An Analysis of Variations in the Bronchovascular Patterns of the Middle Lobe in Fifty Dissected and Twenty Injected Lungs. E. A. Boyden and C. J. Hamre. J. Thoracic Surg. **21**: 172–188, February 1951.

In this paper, illustrated profusely with diagrams in black and white and color, the authors present a study of the bronchovascular patterns of the *middle lobe* in 50 lungs from cadavers and 20 fresh specimens. Earlier articles by Boyden and his associates have covered the right and left lower lobes (see Absts. in Radiology **53**: 288, 1949; **54**: 446, 1950). In the middle lobe the venous or arterial patterns, or both, were found to differ

from the bronchial pattern in 68 per cent of the specimens, indicating that the anatomy of the lobe is not in general favorable for segmental resections.

For details, the original paper should be consulted.

Voluntary "Unilateral Breathing." Emil Rothstein and Robert Strzelczyk. Ann. Int. Med. **34**: 401–406, February 1951.

Fluoroscopic observation of patients trained to breathe unilaterally showed no difference between the movements of the right and left leaves of the diaphragm. Judging from the appearance of the lungs, particularly the lower lobes (in which the markings and their movements are usually easily seen), there was no difference in aeration or expansion. Similar observations were made in 3 patients with pneumothorax.

These examinations suggest that this failure to affect the pulmonary expansion differentially is attributable to the failure to immobilize one leaf of the diaphragm and to a mediastinal shift, observed fluoroscopically, which also equalizes expansion.

Other observations, including bronchospirometry in some cases and manometric readings with a pneumothorax needle *in situ*, bear out the conclusion that the ventilation of the lungs is about the same during unilateral as during bilateral breathing.

Four tables.

Pathologic Picture of Bronchial Insufficiency. A Contribution to the Active Behavior of the Lungs in Respiration. K. Heckmann. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 23–39, January 1951. (In German)

On the basis of changes in radiographic translucency during respiration, the movement of interlobar fissures, and the bronchial "straddling" in body-section films, three types of lung ventilation are differentiated: a cranial, a caudal, and a universal type. During normal respiration, several regions of the lungs do not participate in the respiratory activity. Only in the case of increased oxygen demand do practically all bronchial segments participate ("second wind"). Diseased portions of the lungs are eliminated from the respiratory process by reflex action (Kreuzfuchs' cough phenomenon, Williams' symptom, localization of bronchial metastases, etc.). Acute bronchial insufficiency may lead to the development of cavitation (so-called "suction cavities"), while chronic bronchial insufficiency may produce pulmonary emphysema.

For determination of pulmonary emphysema the author recommends the radiologic function test, which is based on the passive compressibility of the lung tissue. In the healthy individual, the volume of the right lung is diminished by about a third in right decubitus, due to elevation of the hemidiaphragm. In the presence of pulmonary emphysema the cranial displacement of the hemidiaphragm in lateral decubitus is much less pronounced. The compressibility of the left lung can be tested similarly. The same function test is applicable where only suspicion of pulmonary emphysema exists, or in bronchial asthma, not only during the asthmatic attacks but also during asthma-free intervals.

If the assumption is correct that in at least a certain number of cases the stenosis of the bronchial-alveolar system is due to hypertension of the smooth muscles, psychic and nervous factors may play a role not only in bronchial asthma but also in pulmonary emphysema, and the latter condition would have to be considered within the realm of psychosomatic diseases.

Twenty roentgenograms; 6 drawings; 1 photomicrograph.

ERNST A. SCHMIDT, M.D.
Denver, Colo.

Bronchography in Children. Eduardo Rivero. Am. J. Roentgenol. **65**: 173–179, February 1951.

This study of bronchography in children is based on observations made in a sanitarium for childhood tuberculosis in Havana, Cuba. The catheter is introduced with the aid of a metal stylet and is manipulated under fluoroscopic control until it is in the right or left bronchus as desired. With the child positioned on the cassette, lipiodol is injected rapidly. Lateral, oblique, and anterior films are obtained in quick succession. The studies revealed that in primary tuberculosis simple infiltration is the exception, and that the usually described radiographic characteristics comprising the primary complex are often masked by primary and secondary infiltration of the surrounding lung. Atelectasis is the rule and is due to compression of bronchi by enlarged nodes or lesions within the bronchial wall. The atelectasis is usually segmental or lobar, and more frequently involves the middle lobe. After lipiodol instillation the point of bronchial compression may be identified, and in the atelectatic lung distal to the compressed bronchial segment, bronchial dilatation is the rule.

A frequent finding in the bronchographic studies is the presence of circular incomplete constrictions at regular intervals along the involved bronchus, giving the bronchial wall a wavy appearance not unlike a string bean. This is typical of bronchial obstruction in primary tuberculosis regardless of the duration of the disease.

If the collapse becomes permanent, the lobe or segments may appear radiographically as a dense band with radiolucent round or oval zones representing the dilated bronchi. This appearance is usually interpreted as thickening of the interlobar septum or fibrosis. The author believes that chronic atelectasis is more frequent following pulmonary tuberculosis than is usually assumed.

Fourteen bronchograms.

WENDELL WARD, M.D.
University of Arkansas

Delayed Pulmonary Complications of Bronchography. Philip W. Robertson and K. D. Forgan Morle. Lancet **1**: 387, Feb. 17, 1951.

During the investigation of various chest diseases between March 1949 and December 1950, bronchography was performed 220 times at the Royal Infirmary, Liverpool, mostly on young men. Iodized oil was introduced by cricothyroid puncture. No case of classical iodism was seen, but in 16 of the patients a delayed reaction occurred one to two weeks after the bronchographic examination. These reactions were pulmonary in type and were characterized by fever, cough, chest pain, and malaise. In 5 instances the reaction was associated with pleural effusion. Urticaria followed the reaction in 4 patients, one of whom also had transient swelling of the joints of the hands. Recovery was rapid and spontaneous in all cases. No reaction was observed in any patient who had a second bronchogram, whether or not the first procedure was thus complicated.

For control purposes, bronchography was carried out on one of the authors. A similar but more severe reaction occurred on the seventh day.

The authors believe that careful observation of all patients after bronchography would reveal fever on or about the ninth day in an appreciable number and that all patients should be carefully observed for a fortnight after this examination. The mechanism of the delayed reactions has not been determined, but they are probably of an allergic nature.

Experiences in the Diagnosis of Pulmonary Carcinoma. H. Anacker. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 2–14, January 1951. (In German)

This paper is based upon a series of 163 proved cases of carcinoma of the lung among a larger group of 201 cases in which the disease was suspected. Bronchography was found to be of superior importance in the diagnosis, offering utilizable findings in 82 per cent of the cases. The major difficulties are encountered in the demonstration of peripheral involvement. In about one fourth of the cases the chief differential diagnostic problem is the exclusion of chronic inflammatory processes. Unless the tumor is situated in the lower lobe bronchus, an early diagnosis either roentgenologically or by bronchography is in many cases not attainable. According to Herbut the cytological examination of the bronchial secretion gives satisfactory results in 89 per cent of these early lesions.

Fifteen roentgenograms; 3 charts; 1 drawing.

ERNST A. SCHMIDT, M.D.
Denver, Colo.

Contrast Visualization of the Pulmonary Vessels as an Aid in the Early Diagnosis of Pulmonary Neoplasms. Case Report. Robert A. Nabatoff. Ann. Surg. **133**: 270–271, February 1951.

A case is presented in which the symptoms were suggestive of lung carcinoma, but in which regular roentgen study and bronchoscopy revealed no evidence of lung or bronchial abnormality.

Angiocardiography was performed. Medial displacement and elevation of the main branch of the pulmonary artery feeding the right upper lobe was observed, along with deformity of the superior vena cava. Thoracotomy and subsequent tissue study revealed a bronchogenic carcinoma arising from the mucosa of the right main bronchus, which was, however, almost entirely extraluminal and growing in the lung parenchyma.

This study emphasizes another valuable application of contrast visualization of the thoracic vascular tree.

One roentgenogram. JOHN F. RIESSER, M.D.
The Henry Ford Hospital

Bronchogenic Carcinoma Masked by Pulmonary Tuberculosis: Case Report. J. R. Phillips and J. W. Morrison. Dis. of Chest **19**: 201–208, February 1951.

Pulmonary tuberculosis and bronchogenic carcinoma, because of their common qualities of insidious onset, debilitation, similar symptoms such as cough, sputum, hemoptysis, chest pain, and frequently similarity of roentgen findings, are a "well-suited duet to masquerade as a single disease." Bronchogenic carcinoma may suddenly begin in a tuberculous lung and progress for some time without detection especially if the neoplastic lesion tends to mimic or blend into the original tuberculous lesion. The incidence of coexisting primary lung carcinoma and pulmonary tuberculosis is probably higher than is generally believed.

The authors' patient was a 39-year-old white male, with a history of disease for four years. A roentgenogram obtained at the time of the original symptoms had shown an infraclavicular lesion in the left upper lobe compatible with early primary tuberculosis. X-ray inspection now revealed a suggestion of a neoplastic lesion in approximately the same area. A pneumonectomy was performed and tuberculosis and carcinoma were found in the same lung. The tuberculosis is thought to have preceded the cancer by a long time.

The authors cite Fried's suggestion (Am. J. Cancer **23**: 247, 1935) that bronchogenic carcinoma should be suspected to coexist with pulmonary tuberculosis, or exist by itself simulating tuberculosis, in patients past middle age with chest pain and blood-streaked sputum, profound anemia, fatigue, and weight loss, all out of proportion to the tuberculous lesion. Except for the matter of age, all these criteria were present in the case here reported.

Six illustrations, including 3 roentgenograms.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Spontaneous Pneumothorax from Secondary Sarcoma of Lung. A. Batty Shaw. Brit. M. J. **1**: 278–280, Feb. 10, 1951.

The association of pulmonary metastases with spontaneous pneumothorax is rare. In the case reported here, a bilateral spontaneous pneumothorax followed pulmonary metastases from a leiomyosarcoma of the uterus.

The patient was a 51-year-old female who was admitted to the hospital for investigation of the chest. Within the previous year she had had a subtotal hysterectomy for fibroids. No further details of this operation were available, but it was later assumed that she had been suffering from a uterine leiomyosarcoma rather than a benign fibroid. Roentgenograms of the chest showed a left-sided pneumothorax with scattered rounded opacities in both lung fields. A needle biopsy revealed the malignant character of the lesions. On vaginal examination a firm mass was found in the right fornix. Necropsy showed pneumothoraces which were almost certainly caused by bronchopleural fistulae arising from necrotic pleural metastases. The pelvic mass proved to be a well differentiated leiomyosarcoma replacing the right ovary.

Lodmell and Capps reported 3 cases of pneumothorax associated with metastases (Radiology **52**: 88, 1949). In 2 of these cases the pneumothorax was attributed to a ball-valve obstruction of the bronchus by tumor nodules, with distention and subsequent rupture of the peripheral alveoli.

One roentgenogram.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Primary Solitary Neurogenic Tumors of the Lung. Walter Diveley and Rollin A. Daniel, Jr. J. Thoracic Surg. **21**: 194–201, February 1951.

Two cases of solitary primary neurogenic tumor of the lung are reported, a benign neurofibroma and a neurogenic sarcoma. A review of the literature revealed only 2 other examples, one benign and one malignant.

The neurofibroma reported here occurred in a 35-year-old male, who complained of vague aches in the left shoulder region. A well circumscribed ovoid mass some 5 cm. in diameter was demonstrated roentgenologically in the right middle lobe. The appearance suggested that it might be metastatic, but pyelograms and additional studies were normal. Study after lobectomy demonstrated its true nature.

The neurogenic sarcoma was removed from a 48-year-old male, who complained of abdominal distention and "gas crowding his heart." He gave a history of "pneumonia" a year earlier, which kept him bedridden for six months. During that time he lost 45 pounds, though he experienced no loss of appetite. Chest x-ray studies demonstrated a homogeneous density in the upper third of the left hemithorax. The upper mediastinum and trachea were shifted slightly to the left. No tumor cells appeared in bronchial washings. At thoracotomy a hard mass was found completely filling the upper lobe of the left lung and hard tumor nodules were felt within the mediastinum. The patient died four months after removal of the lung. Chest roentgenography one month before death disclosed a horizontal, midthoracic band of increased density in the right lung. This was interpreted as being an extension of the neurogenic sarcoma from the mediastinum.

Four roentgenograms; 4 photomicrographs.

DONALD DEF. BAUER, M.D.
St. Paul, Minn.

Segmental Distribution of Shrinkage of Parts of the Lungs, with Bronchiectasis Formation. Paul Ch. Schmid. Fortschr. a. d. Geb. d. Röntgenstrahlen **73**: 689–702, December 1950. (In German)

In childhood, primary tuberculosis may be the cause of shrinkage of entire pulmonary lobes or segments, the subsequent recognition of which may be very important to the chest surgeon. The enlarged lymph nodes in primary tuberculosis may produce atelectasis with subsequent shrinkage as a result either of compression or erosion, with blockage of the bronchi. In very young children with pliable bronchial trees, one encounters compression of the bronchi leading to an entire lobe or sometimes even of a main-stem bronchus. In older children, with more rigid bronchi, the compression occurs instead in the smaller branches and a segmental shrinkage results. After arrest or healing of the tuberculous lesion, the atelectasis may disappear, but occasionally the lung remains permanently shrunken, with bronchiectasis formation. This can be explained by secondary damage to the bronchial wall, which gives way during forced breathing and coughing. The atelectasis depends upon the location of the enlarged lymph nodes draining from the primary focus, which may be located in a different lobe than the atelectatic process. For example, atelectasis and shrinkage of the middle lobe may occur when the primary focus is located in the lower lobe, since part of its drainage enters lymph nodes surrounding the middle lobe bronchus. Also, the pectoral segment of the upper lobe is quite often involved, as it is easily compressed by enlarged lymph nodes surrounding it.

Upper Lobe: Atelectasis or shrinkage of the entire upper lobe is seen comparatively often, and tomograms or bronchograms are extremely helpful in the diagnosis. The pectoral segment of the upper lobe, especially on the right side, is the most frequently involved in segmental shrinkage, and in the posteroanterior view one can usually recognize a mesial convex and a lateral upward-directed concave density. Although in the beginning both parts of the pectoral lobe may be involved, the process may reverse itself in one part and progress in the other.

Middle Lobe: Primary tuberculosis in children can often be the cause of shrinkage of the middle lobe, which assumes a wedge-shaped appearance in the lower half of the right hemithorax, with the base of the wedge near the anterior wall and the apex pointing toward the hilar region. In markedly advanced shrinkage, one sees only a very thin band of density extending from the hilar region anteriorly and downward toward the diaphragm; this type of shrinkage is sometimes wrongly diagnosed as interlobar pleuritis. In the postero-anterior view the borders of this band are not sharply delineated, but in the lordotic position one sees a sharply demarcated triangular radiopacity, with its base at the border of the heart and its apex laterally. Occasionally only a part of the middle lobe may become atelectatic and shrunken.

Lingula: Changes similar to those noted in the right middle lobe can be seen in the lingula. This lobe is often involved in the presence of bronchiectasis in the left lower lobe.

Lower Lobe: The shrunken lower lobe is seen as a triangular opacity near and behind the heart, with the base directed toward the diaphragm and filling the cardiophrenic angle; this pattern is sometimes wrongly diagnosed as localized mediastinal-diaphragmatic pleuritis. Subsequent bronchiectasis in the lower lobes may be segmental in distribution or may involve the entire lobe; it is more often saccular than cylindrical in type as contrasted to bronchiectasis occurring in the middle and upper lobes, a finding which may be explained by the fact that the upper and middle lobes empty much more easily.

Twenty-four roentgenograms.

JULIAN O. SALIK, M.D.
Baltimore, Md.

Observations on Division of Adhesions in Opaque Lobes. Alfred J. Coello. J. Thoracic Surg. **21**: 135–148, February 1951.

Opaque pulmonary lobes seen in the presence of pneumothorax are of two types. The differentiation is of prognostic importance. With the radiologically *triangular type*, which appears wrinkled and dark blue on thoracoscopy, a large percentage of cavity closures may be anticipated. Adhesion section in this type should consist mainly in freeing the lung from surrounding mobile structures without aiming at complete division.

The radiologically *round type* of opaque lobe appears shiny and gray on thoracoscopy. Artificial pneumothorax in this group is often dangerous, and division of adhesions does not alter matters. Pneumoperitoneum and phrenic crush in preparation for collapse or excision are preferable to pneumothorax in such cases.

Five roentgenograms; 29 drawings.

DONALD DEF. BAUER, M. D.
St. Paul, Minn.

Diffuse Bilateral Fibrocystic Disease of Lungs (Honey-Comb Lungs). Leroy Hyde, Bernard Hyde, and Charles Pokorny. Dis. of Chest **19**: 190–200, February 1951.

The authors report 4 cases of diffuse bilateral fibrocystic disease of the lungs. Two cases were proved at

autopsy, and 2 patients are now living and well. Cystic lesions of the lungs are of two types: (1) those derived from alveoli, as solitary alveolar cyst, pneumatocele, and cystic emphysema, and (2) those derived from bronchi, as solitary or multiple bronchial cysts or cystic bronchiectasis. Cysts of the lungs manifest at birth or infancy are the result of faulty development and are derived from bronchi and bronchioles and not from the alveoli.

Roentgenographic differentiation of cystic lesions of the lungs may be difficult. Large cysts, single or multiple, in patients of middle age or older, often with emphysema, are alveolar cysts and may be termed cystic emphysema. The lobular or lobar areas of cystic bronchiectasis are simply a variation of the latter disease. Diffuse bilateral fibrocystic disease of the lungs (so-called "honeycomb" lungs) is a different entity. It occurs in young patients, usually males, and often leads to cor pulmonale and death. The cause is unknown. Norris and Tyson (Am. J. Path. **23**: 1075, 1947) believe the fundamental lesion to be focal segmentation preceded or followed by focal dilatation of small bronchi and bronchioles. Isolated bronchial segments may gradually develop into cysts.

Three roentgenograms; 1 photograph; 1 photomicrograph. HENRY K. TAYLOR, M.D.
New York, N. Y.

Diabetes Insipidus with Honeycomb Lungs: Presumed Normocholesteraemic Xanthomatosis. A. A. G. Lewis and J. Smart. Proc. Roy. Soc. Med. **44**: 166–168, February 1951.

A case of "honeycomb lung," *i.e.*, a uniform distribution throughout the lungs of thin-walled cysts 1 cm. or less in diameter, is reported in a patient with diabetes insipidus. The association of the two conditions has been reported by others. It is believed by the authors that such cases fall into the group designated by Thannhauser and Magendantz (Ann. Int. Med. **11**: 1662, 1938) as normocholesteremic xanthomatosis, which includes Hand-Schüller-Christian disease, eosinophilic granuloma of bone, Letterer-Siwe disease, and cutaneous xanthoma disseminata.

Three roentgenograms.

Syphilis of the Lung. Case Confirmed by Autopsy. E. Vogler. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 107, January 1951. (In German)

Relatively few cases of syphilis of the lung confirmed histologically have been reported. Vogler describes the case of a 56-year-old woman in whom, in 1948, a clinical diagnosis of cardiac decompensation and syphilitic mesaortitis had been made. On readmission to the hospital in 1949, on account of recurrence of cardiac decompensation, the roentgenogram of the chest showed considerable fibrosis in the middle third of the left lung, combined with indistinctly outlined areas of infiltration. The interlobar fissure was prominent. The heart was markedly displaced to the left. The patient died from acute cardiac failure in consequence of peritonitis. The pathologic diagnosis was: "Syphilis of the left lung; syphilitic mesaortitis with aortic insufficiency; hypertrophy and dilatation of all portions of the heart; streptococcus peritonitis." The left lung was completely adherent and markedly shrunk, whitish on section, and interspersed with extensive cicatricial tissue. The right lung showed no gross changes, was not adherent, and was about twice as large as the shrunken left lung. Histologic examination showed the typical changes of chronic interstitial syphilitic pneumonia. The indurated cicatricial area extended in the surrounding lung tissue and represented perivasal and interalveolar proliferation of connective tissue. The blood vessels were partly obliterated. The interalveolar septa were thickened. Localized collapse induration was also noted.

One roentgenogram; 1 photomicrograph.
ERNST A. SCHMIDT, M.D.
Denver, Colo.

Generalized Softening in the Tracheobronchial System. R. Pohl. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 40–43, January 1951. (In German)

Unlike localized tracheal malacias due to extrinsic pressure (goiter, mediastinal tumors, etc.), general malacic changes throughout the entire tracheo-bronchial system are rare. Pohl describes the case of a 64-year-old man suffering from pulmonary emphysema, bilateral basal fibrosis, and infiltration. The patient gave a history of syphilis (forty years earlier) and three attacks of pneumonia (during the preceding fifteen years). The main symptoms at hospital admission were cough with purulent sputum and dyspnea. Lipiodol bronchography showed relative narrowness of the trachea in the laryngeal portion and at the bifurcation but sausage-like dilatation in the intermediate areas, with accentuation of the segmental subdivisions. The greater bronchial branches presented a similar appearance of dilatation with wavy borders. Peripherally, the bronchial system showed multiple areas of dilatation alternating with stenotic areas. Fluoroscopically, the slow progress of the lipiodol through the trachea and the larger bronchial branches was striking, and their configuration changed continuously. Air, secretion, and lipiodol were seen mixing and undulating, as in a "boiling pot." This unusual picture appeared due less to activity of the bronchial musculature than to passive deformation in consequence of loss of connective tissue. After bronchography, the dyspnea further increased, the insufficiency of the pulmonary circulation became more marked, and the patient died three days later.

The pathologist reported a peculiar tracheo-bronchopathy: saber-shaped and dilated trachea, with thickening of the tracheal cartilages and gutter-like collapse of the intercartilaginous parts of the trachea; diffuse bronchiectasis, predominantly cylindrical, but also saccular, in both lungs, most pronounced in the lower lobes; scattered small foci of shrinkage in both lower lobes; considerable chronic vesicular emphysema; extensive pleural adhesions over both upper lobes; acute fibrinous pleuritis over both lower lobes.

Similar pathologic pictures have been described by Aschoff, Schnitzer, and Moltrecht. Congenital weakness of the fibrous tissue with chronic inflammatory irritation over many years (in the present case, syphilis and pneumonitis) is assumed to form the etiologic basis.

Three roentgenograms. ERNST A. SCHMIDT, M.D.
Denver, Colo.

Centrally Caused Edema of the Lung. Victor Buchtala. Fortschr. a. d. Geb. d. Röntgenstrahlen **73**: 702–712, December 1950. (In German)

The author reports 15 cases of edema of the lung whose origin, according to him, lies in disturbances of permeability of the pulmonary blood vessels conditioned

by pathological changes in the diencephalon. These changes can occur in the presence of increased intracranial pressure, during epileptic seizures, in nephritis, in drowning without aspiration of water, and in contusions of the thorax. The characteristic pattern is a generalized haziness, like a fog, enveloping both lungs. The roentgen findings, which may be evident before the clinical manifestations occur, are termed by the author silent, early signs of this type of edema. He subdivides the roentgen pattern into an initial stage with hyperemia, slight haziness, and finally added foci of a bronchopneumonic type near the hilar regions.

Twenty roentgenograms.

JULIAN O. SALIK, M.D.
Baltimore, Md.

Roentgen Picture of the Ochre-Dust Lung. R. Haubrich. Fortschr. a. d. Geb. d. Röntgenstrahlen **73:** 682–688, December 1950. (In German)

The author presents 8 cases of pneumoconiosis in men who were employed as ochre (earth dye) millers. The usual roentgen pattern is similar to that seen in silicosis and is characterized by finely granular and stippled areas with a reticulated appearance. This same pattern is also seen in iron-dust silicosis, the difference being that ochre pneumoconiosis occurs only after exposure lasting many more years. None of the cases was proved by necropsy. The roentgen picture corresponds usually to Stage I and later to Stage II of silicosis, mainly with involvement of the mid segments of the lungs and later the upper segments, while the basal segments are emphysematons.

The author discusses the underlying pathology and interstitial distribution of the changes in ochre pneumoconiosis and iron-dust silicosis, due to the action of silicic acid, and contrasts them with siderosis and hemosiderosis, which have an alveolar distribution. The latter may show some roentgen evidence of improvement if the causative agent is removed or if there is improvement of the function of the heart, whereas pneumoconiosis and iron-dust silicosis may show a progression of the disease even after the patient ceases to be subjected to the causative agent.

Six roentgenograms. JULIAN O. SALIK, M.D.
Baltimore, Md.

The Bullet Tract in the Lung. R. Pohl. Fortschr. a. d. Geb. d. Röntgenstrahlen **74:** 108–109, January 1951. (In German)

Among 80 cases of recent bullet wounds of the lungs, the author found 2 which were definitely atypical. While the usual manifestations (more or less extensive pleural effusion, displacement of the mediastinum, pulmonary infiltration) were absent, these 2 cases showed roentgenographically clear-cut bullet channels resembling drainage tubes. No complications were noted. The appearance was apparently due to the great penetration of the high-speed projectile with clear-cut mechanical, thermic, and chemical effects on the lung tissues during its passage. According to Beitzke, a tube-like bullet canal in the roentgenogram represents a zone of cylindrical traumatic eschar formation in the immediately surrounding tissue. While Pohl was unable to obtain follow-up examinations of the two cases, he assumes that healing ensued without difficulty and probably with only very slight scar formation.

Two roentgenograms. ERNST A. SCHMIDT, M.D.
Denver, Colo.

Mass Radiography in the South Wales Valleys. T. A. Blyton. Irish J. M. Sc., January 1951, pp. 10–14.

Mass radiography in South Wales has been conducted with mobile radiographic units, since few large factories and public halls were available for such studies.

The present report covers a period of six years and brings out certain findings of interest which may be peculiar to the area involved. The number of clinically significant cases of pulmonary tuberculosis detected declined steadily in each of the six years of the survey. It was found that the incidence of tuberculous lesions was much lower in persons that volunteered for the survey than in those requiring some persuasion to be examined.

Of the non-tuberculous lesions discovered, pneumoconiosis was most important; 0.9 per cent of all persons examined by mass radiography in South Wales had pneumoconiosis. Cardiovascular disease was found in 0.28 per cent.

Four tables. PAUL W. ROMAN, M.D.
Baltimore, Md.

Intrathoracic Meningocele, Spinal Deformity, and Multiple Neurofibromatosis. A. W. Lipmann Kessel. J. Bone & Joint Surg. **33-B:** 87-93, February 1951.

The author has collected 8 cases of lateral intrathoracic meningocele from the literature and added two personal cases. Seven of the 10 occurred in association with multiple neurofibromatosis. Roentgenograms in the author's cases showed scalloping of the vertebral bodies. A similar picture was obtained in a woman with neurofibromatosis who died of a cerebral tumor. In this latter case postmortem examination showed deformity of several vertebrae, apparently hollowed out by the distended theca, which bulged through the intervertebral foramina. On this basis, it is suggested that the spinal deformity in von Recklinghausen's disease may be due to prolonged aneurysmal action of an undisclosed meningocele or an intrathecal dilatation of the dura mater.

Eleven illustrations, including 7 roentgenograms.
J. G. LORMAN, M.D.
Indiana University

Mediastinal Teratoma. Frank T. Fralick and Hugh S. Welsman. Dis. of Chest **19:** 209–220, February 1951.

The authors report 2 cases of unsuspected mediastinal teratoma found in mass chest surveys. The first one, in a 38-year-old female, proved to be benign; the second, in a 16-year-old male, was malignant.

Teratomas are complex tumors originating in embryonic life. They are derived from all three germ layers and may exhibit any combination of tissues. They are predominantly cystic. Sebaceous material and hair are usually present in the cysts. Bone, cartilage, teeth, muscle, nerve tissue, and occasionally rudimentary organs, are found in the solid portion. Both cystic and solid teratomas are potentially malignant. The tumor may remain small and dormant throughout life, being found unexpectedly at autopsy. On the other hand, it may have a tendency to grow in adolescence and early adult life. Progressive enlargement will ultimately produce symptoms due to pressure.

Teratomas of the mediastinum occupy an anterior position beneath the sternum. They are usually apparent radiologically as globular or circular masses with clear-cut edges, of homogeneous density, though occa-

sionally more opaque areas may be present, representing teeth or bone. The wall may be partially calcified. A fluid level may indicate communication with a bronchus. An irregular lobulated appearance is suggestive of malignancy.

Eight roentgenograms.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Roentgen Examination of Pleural Fluid. A Study of the Localization of Free Effusions, the Potentialities of Diagnosing Minimal Quantities of Fluid and Its Existence under Physiological Conditions. Ingemar Hessén. Acta radiol., Suppl. 86, 1951.

In cases of pleural effusion there is competition between the lungs and the fluid for space in the chest cavity. When the lung is of normal consistency and there are no pleural adhesions, the fluid obeys the law of gravity and the air-containing lung floats up on it. In the postero-anterior view (erect) the fluid line differs typically from the configuration of the arch of the diaphragm. The line either (*a*) runs from the mediastinum with a slight upward inclination laterally to a point beyond the highest part of the diaphragmatic arch and then angles sharply downward to the chest wall, or (*b*) it takes a horizontal course before turning down toward the chest wall.

Since the posterior pleural sinus is the deepest of the sinuses, the fluid gathers there in larger amounts than elsewhere, the fluid pressure is highest there, and the lung is permitted greater retraction. Consequently, the erect lateral film shows the posterior collection of fluid tapering cranially and dorsally to the lung.

When the lung is of abnormal consistency and there are no pleural adhesions present, the localization of fluid is governed by the same principles. In the presence of pleural adhesions, however, the fluid encloses the lung in the fashion of a mantle, being acted upon by gravity within the limits imposed by the presence and position of the adhesions—the lung floating where it can and displacing the fluid at the points of adherence.

Small amounts of fluid may be demonstrated in the lateral decubitus position, which the author modifies by elevating the hips and rotating the chest to bring the scapula parallel to the table top so that the trunk tilts obliquely and cranially. In this position an undulating surface and absence of change in thickness with respiration indicate soft-tissue density, while fluid in this position appears as a convex arch narrowing toward the diaphragmatic and cranial parts of the thorax. Such an effusion varies in thickness with the phases of respiration.

In a study of 300 persons with normal hearts and lungs, physiological pleural fluid could be shown in 4 per cent, or if the cases where the diagnosis of fluid was uncertain are included, in 10.3 per cent. Physiological pleural effusion may be unilateral or bilateral, constant or transitory. The thickest layer of fluid in this series was 10 mm., as measured perpendicular to the fluid border against the lung. In a study of 92 postpartum females pleural effusion was present in 22.8 per cent or, including the doubtful cases, in 38 per cent. In no case of postpartum effusion did the quantity of fluid exceed that in simple physiological effusion. No increase in pleural fluid was found after physical exercise in a study of 9 persons.

The conclusions regarding localization of fluid are based on careful study of 12 cases, 4 cadavers, and 4 rabbits.

One hundred roentgenograms; 2 photographs; 1 diagram; 5 tables.

RICHARD F. MCCLURE, M.D.
The Henry Ford Hospital

Interlobar Hydrothorax in Cardiac Failure. R. F. Robertson. Brit. Heart J. **13**: 112–114, January 1951.

Including the case presented here, only 36 cases of cardiac interlobar hydrothorax have been reported. In 24 of the 29 cases in which the site was given, the interlobar fluid was in the right lesser fissure. In 27 of the 36 cases, the etiology of the cardiac failure was stated; in all it was a condition causing either left-sided or simultaneous left- and right-sided failure, namely, aortic valve disease, hypertension, coronary occlusion, and myocardial fibrosis. In accordance with such etiology, the age incidence is high, 23 of 28 patients being over forty years old.

In 14 of the 36 cases, there was no accompanying effusion in the general pleural cavities. In such instances, the correct diagnosis may not be thought of at first because of its rarity. Tuberculous loculated pleural effusion, loculated empyema, or even neoplasm may be considered. A patient with coronary occlusion, which is a common cause of cardiac interlobar hydrothorax, may have fever, cough, chest pain, and leukocytosis, all of which may suggest empyema.

Cardiac interlobar hydrothorax, however, as pointed out above, usually occurs in patients over forty years of age, when tuberculous effusions are uncommon. A cardiac condition causing left- or simultaneous left- and right-sided failure is present. The fluid has the characteristics of a transudate. Radiologically, it is in most cases localized in the right lesser fissure and tends to disappear with treatment of the cardiac failure and to reappear with relapse; the lung fields tend to show hilar and basal congestion due to associated pulmonary edema.

Necropsy in some cases has shown that fibrous obliteration of the general pleural cavities has left no space other than an interlobar fissure in which the fluid could accumulate.

Two roentgenograms.

Situs Inversus of the Abdominal Viscera with Levocardia. Report of Eight Cases Submitted to the Blalock-Taussig Operation. Maurice D. Young and Herbert E. Griswold. Circulation **3**: 202–214, February 1951.

When situs inversus of the abdominal viscera occurs in association with levocardia, the heart is apt to present very complicated anomalies, as demonstrated by this series of 8 cases submitted to the Blalock-Taussig operation. Inadequate pulmonary blood flow was demonstrated in every case in this series. The aorta and its main branches bore a mirror image relationship to the normal anatomy in 6 of the 8 cases. Anomalies of the systemic venous return to the heart occurred in 7 cases. Anomalies of the pulmonary venous return were demonstrated in 4 cases and suspected in one additional case. A communication between the auricles was found in each of 4 cases. The aorta was dextroposed in each case; it was completely transposed in one case, and mainly transposed in another. Transposition of both great vessels was demonstrated in 2 cases and postulated in 3 others.

While the series is small, the authors stress the high operative mortality in comparison to simple tetralogy of Fallot. Three of the 8 patients died.

It is pointed out that when the heart is on the left side it is easy to overlook the abdominal situs inversus. The authors advise glancing at the abdomen routinely when fluoroscoping patients with congenital cardiac disease to determine the position of the stomach and liver.

It is worth noting that, while only 14 other cases with this combination of anomalies have been reported in the literature, there was an associated congenital heart lesion *in every one*.

Eight roentgenograms; 2 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Diagnostic Value of Dynamic Studies in Angiocardiography. Evaluation of New Rapid Technique. T. F. Keyes, C. Wegelius, and J. Lind. J. Thoracic Surg. **21**: 164–171, February 1951.

Increased applicability of angiocardiography as a diagnostic tool of the thoracic surgeon is foreseen with the introduction of continuous visual registration of the dynamics of the heart. Technical developments permitting roentgenograms up to 16 per second in each of two planes are reported. This speed is comparable to the 16 frames per second of silent movies.

At Stockholm's Norrtull Hospital, special apparatus has been constructed. A 1000-ma. generator delivers 100 kv.p. to each of two tubes. Synchronous exposures in planes at right angles are taken simultaneously with electrocardiographic registration of the cardiac cycle, as the radiopaque dye circulates. The electrical supply frequency is 50-cycle and exposures are therefore made at multiples of 0.02 seconds. The cassette-changing device permits up to seventy cassettes or exposures in each plane. The cassette gear is similar in the horizontal and vertical planes, with synchronous drive by a common motor. The limitation of the number of pictures which can be taken per minute is imposed not by the generator but by the cassette changer: 16 per second.

Fifteen roentgenograms.

DONALD DEF. BAUER, M.D.
St. Paul, Minn.

Angiocardiographic Findings in Thoracoplasty, Artificial Pneumoperitoneum, and Phreniclasia. Herbert I. McCoy, Israel Steinberg, and Charles T. Dotter. J. Thoracic Surg. **21**: 149–158, February 1951.

Diminished vascularity in the portion of lung subjected to therapeutic collapse is demonstrable by angiography during life. The studies reported here were done in cases of tuberculosis and represent actual clinical conditions. Seventeen patients were studied at varying intervals before, during, and after collapse therapy in the form of thoracoplasty, artificial pneumoperitoneum, phrenic nerve crush, or a combination of the two latter procedures. Neo-iopax, 75 per cent, or diodrast, 70 per cent, was used as the radiopaque dye. Diminished vascularity of varying degree was common to all the forms of collapse. Thoracoplasty, like pneumothorax, resulted in a marked diminution in opacification of the pulmonary arterial tree on the collapsed side. There was a diminution in caliber with delay and nonfilling of pulmonary vessels. Often a shift of the heart and great vessels away from the side operated upon occurred. Following artificial pneumoperitoneum the diminution in pulmonary vascularity was found to be roughly proportionate to the degree of elevation of the diaphragm. Upward displacement and rotation of the heart and great vessels was demonstrated. These effects were more pronounced when a phrenic nerve crush was added. In phrenic nerve crush alone only moderate decrease in pulmonary vascularity was noted.

Twelve roentgenograms.

DONALD DEF. BAUER, M.D.
St. Paul, Minn.

Congenital Heart Disease. II. Angiocardiography, Aortography and Cardiac Catheterization. Daniel F. Downing, Nicholas A. Antonius, Sol Parent, Henry Green, Allen Welkind, and Francis P. Carrigan. J. M. Soc. New Jersey **48**: 47–50, February 1951.

The three procedures listed in the title of this paper are discussed rather briefly from the standpoints of technic, indications, dangers, contraindications, reactions, and possible findings. No illustrations are given but the points which are covered are covered well. In general, the authors believe that angiocardiography is of the greatest value in cyanotic congenital cardiac lesions and probably should be done in every case of this sort. Aortography is the procedure of choice to outline the aorta or its branches or possible communications. Cardiac catheterization is most helpful in cases with a left-to-right shunt, where angiocardiography is least valuable.

One table.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Visualization of the Coronary Arteries During Life. James A. Helmsworth, Johnson McGuire, Benjamin Felson, and Ralph C. Scott. Circulation **3**: 282–288, February 1951.

In an earlier communication (Am. J. Roentgenol. **64**: 196, 1950. Abst. in Radiology **56**: 909, 1951), the authors described a method of visualization of the coronary arteries by injection of a radiopaque medium through a catheter inserted *via* the brachial artery into the ascending aorta. Here the technic is described, and the hazards of coronary arteriography are considered. Further experiences in this field are also presented.

After retrograde catheterization of the aorta to within about 1 cm. of the valve, 75 per cent neo-iopax or 70 per cent diodrast is injected forcibly and rapid serial roentgenograms are made. Good visualization of the coronary system was obtained in dogs provided the catheter could be inserted into the ascending aorta. *Five out of 15 animals died following the procedure*, all 5 having had recent coronary ligations.

The procedure was attempted in 10 patients (indications not stated) with some success in 5 instances and with 1 fatality, this last in an 88-year-old moribund woman who died after the sixth injection of 10 c.c. of 70 per cent diodrast.

It seems difficult to reconcile use of such a dangerous procedure to diagnose coronary artery disease when harmless methods are available which are much more consistent and at present more accurate. The authors themselves recommend that for the present, at least, it be limited to experimental investigations. It should be useful in the study of coronary disease in animals.

Six roentgenograms; 4 drawings.

ZAC. F. ENDRESS, M.D.
Pontiac, Mich.

Stenosis of the Isthmus of the Aorta. Roentgenkymographic Studies of Normal and Diseased Hearts, the Great Vessels, and Transmitted Pulsations. Alfred Vogt. Fortschr. a. d. Geb. d. Röntgenstrahlen **74:** 159–173, February 1951. (In German)

Resection for isthmus stenosis was first done by Crafoord in 1944 with end-to-end anastomosis. While it is not advisable in elderly patients showing aneurysm or extensive sclerotic changes, it is considered of extreme value and in many cases life-saving. Angiocardiography is not essential for diagnosis in most cases but will aid in determining the position and extent of the stenosis, demonstrating the presence of associated aneurysm and indicating the possibility of successful operative intervention.

The author discusses the morphological difference between infantile and adult types of stenosis, comments on the collateral circulation in the adult, and describes the usual clinical picture. He stresses the fact that cardiac configuration is not a reliable indication of the presence of stenosis, showing ten examples of varying size and shape, none of which was characteristic except for rather constant enlargement of the left ventricle. Aneurysmal dilatation is usually found proximal to the stenosis, but may be distal if the narrowing is of relatively low grade. Fenestration or erosion of the ribs is not a constant finding and cannot be relied upon to indicate the level of the stenosis.

Roentgen kymography, especially in the oblique projections, is recommended for confirmatory evidence, making it possible in some cases to demonstrate the aneurysmal dilatation above the stenosis. Very seldom can the stenotic area be localized or its extent determined. Sometimes atypical waves, shallow and irregular, are noted at the cardiac apex. In many cases, it is possible to observe exaggerated waves above the stenotic area and diminished waves below.

Roentgen kymography is therefore regarded merely as an adjunct in the diagnosis of isthmus stenosis; it does not contribute to determination of the location or extent of the lesion in the average case.

Thirty roentgenograms; 1 table.

E. W. SPACKMAN, M.D.
Fort Worth, Texas

Diagnosis of Aortic Stenosis Based on a Study of 25 Proved Cases. David Lewes. Brit. M. J. **1:** 211–216, Feb. 3, 1951.

The author analyzes 25 proved cases of isolated aortic stenosis and compares his findings with the "classical" picture. Only a small percentage of the group reported here would have been diagnosed on the basis of (1) a slowly rising pulse, (2) aortic systolic murmur and thrill, and (3) absence of the aortic second sound.

The majority of the patients had spent a long life of activity untroubled by heart complaints until the sixth or seventh decade. The onset of symptoms was usually sudden. In four-fifths of the cases the duration was less than four years, though the extent of calcification of the aortic valves as demonstrated at autopsy indicated in every instance significant stenosis of long standing. Cerebral symptoms were unusually common in this group (fainting, dizziness, confusion, etc.), occurring in 8 out of the 25 cases.

The pulse was not consistently small or slowly rising; in some it was full and even collapsing. A systolic thrill in the second right intercostal space was a helpful sign, but it was absent in some instances and atypical in location in others. A harsh systolic murmur was nearly always present but was sometimes associated with mitral systolic and, in half of the series, with aortic diastolic murmurs, indicating some insufficiency. The aortic second sound was absent in only 4 of the 25 cases and diminished in 2 others. Pulse pressure was not consistently low.

Unfortunately only 5 cases were studied fluoroscopically in search of calcification of the aortic valves. It was found in 3, in 1 of which the only physical sign was a systolic murmur.

While radiology was of limited diagnostic value in this series, its importance is considered unquestionable. If every case of suspected heart disease with a rough aortic systolic murmur were screened by the proper technic, or submitted to tomography, few cases of established aortic stenosis would be missed. Routine investigation in this manner would also serve to prevent unwarranted cardiac invalidism through the making of a diagnosis of aortic stenosis in such conditions as hypertension and aortic sclerosis, which are often accompanied by an aortic systolic murmur.

Five tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Contribution to the X-Ray Diagnosis of Aneurysm of the Ascending Aorta. Kurt Breckhoff. Fortschr. a. d. Geb. d. Röntgenstrahlen **74:** 43–46, January 1951. (In German)

Only a few cases have been reported in the literature in which aneurysm of the ascending aorta appeared as a deformity over the left heart border. Assmann (Die klinische Röntgendiagnostik der inneren Erkrankungen, 6th ed., 1949. Figs. 158 and 172) presented two such cases and a third case was described by Kienböck and Weiss (Wien Arch. f. inn. Med. **23:** 373, 1933). Breckhoff reports a fourth case which is further significant in that it proved not to be a true aneurysm (with dilatation of all elements of the aorta) but a spurious aneurysm in which the wall of the aneurysmal sac consisted solely of connective tissue with calcium deposits.

The patient had been observed over a period of four years. He was first admitted to the hospital in 1945, at sixty years of age, complaining of dyspnea, cough, and expectoration. The shadow extending from the left heart border into the lung fields was diagnosed as mediastinal tumor and he received deep x-ray therapy. Two years later he was readmitted on account of cardiac decompensation. He now admitted a syphilitic infection thirty years previously, for which he had received three treatment series. According to his statement, the shadow over the left mediastinum had been first demonstrated in 1930. In the differential diagnosis, cyst formation and pericardial diverticulum were also considered. Cardiac decompensation necessitated further admissions to the hospital and the patient eventually died from bronchopneumonia. The diagnosis of spurious aneurysm of the descending aorta was confirmed by autopsy. The fact that no rupture of the aneurysm had taken place in spite of continuous and increasing enlargement could probably be explained by the considerable thickening of the aneurysmal sac and the marked calcium deposits.

Two roentgenograms.

ERNST A. SCHMIDT, M.D.
Denver, Colo.

Multiple Aortic Aneurysms with Unusual Locations. Richard Haubrich. Fortschr. a. d. Geb. d. Röntgenstrahlen **74:** 137–142, February 1951. (In German)

Multiple aneurysms of the aorta are relatively seldom observed. They are seen most frequently in the ascending aorta and the arch, occasionally in the ascending aorta, arch, and descending aorta, and rarely in the arch and descending aorta.

The author presents a case of double aneurysm of the sinus of Valsalva, a particularly rare finding, as even a single aneurysm at this site is unusual. There was an uncertain history of previous venereal disease. Two rounded shadows were observed fluoroscopically and on the x-ray film, projecting to the right of the heart. The larger contained calcium about the periphery; the smaller extended to the right and posteriorly. Definite pulsations were observed fluoroscopically and by kymography, apparently of the transmitted type. Of the differential possibilities, malignant tumor was ruled out because of the unchanged course over a period of time; dermoid cyst was considered highly improbable because of the double shadow and homogeneous density; pericardial cyst was regarded as unlikely because of the location.

A second patient, known to have syphilis, showed a rounded mass with a calcified outline extending from the base of the aorta, eroding the lower portion of the sternum, and apparently arising from the ventral sinus of Valsalva. There was an associated aneurysm of the arch with a partially calcified border.

The third case reported is of double aneurysm involving the aortic arch and descending portion of the aorta, with displacement of the esophagus and trachea to the right, depression of the left main bronchus and displacement toward the right, and erosion of three thoracic vertebral bodies. In spite of negative serologic tests, the condition was believed to be on a syphilitic basis. The aneurysm of the descending aorta was probably of the dissecting type.

Multiple aneurysms often show a difference in size, the smaller being regarded as "daughter aneurysms." The possibility that double aneurysms may develop on the basis of trauma is mentioned.

Eight roentgenograms. E. W. SPACKMAN, M.D.
Fort Worth, Texas

Unipolar Electrocardiography in Pulmonary Stenosis. R. M. Marquis. Brit. Heart J. **13:** 89–101, January 1951.

Seven cases, 4 with necropsy findings, are presented to illustrate the developing and fully developed electrocardiographic pattern of extreme right ventricular hypertrophy common in the severer grades of pulmonary stenosis when the ventricular septum is intact. Their similarity suggests that the development of this pattern is independent of clinical or radiological variation, the state of the atrial septum, the exact site of the stenosis and, as would be expected, the state of the pulmonary artery beyond the stenosis. The chief characteristics of the pattern are seen in the chest leads: they show tall R waves, S-T depression, and deep inversion of the T waves extending far across the left side of the chest. It is suggested that the right ventricle hypertrophies in proportion to the degree of the stenosis in relation to the right ventricular output, and that unipolar electrocardiography, by recording the extent of the hypertrophy, affords an accurate measure of the severity of the stenosis.

Three roentgenograms; 7 electrocardiograms; 2 photomicrographs.

THE DIGESTIVE SYSTEM

Roentgenologic Examination of the Esophagus. Lilian Donaldson. S. Clin. North America **31:** 21–38, February 1951.

Briefly but thoroughly the author presents an excellent summary of the roentgen examination of the esophagus. The technics of fluoroscopy and filming are included with discussion of the use of the Valsalva maneuver and the influence of various positions. The hypopharynx and cervical esophagus are covered and it is pointed out that, while some radiologists feel that the examination of this region should be left to the endoscopist, roentgen studies may in some instances be of considerable help.

The roentgen characteristics and methods of demonstrating them are given for practically all the conditions which may involve the esophagus: benign and malignant tumors, ulceration, stricture, acute inflammation, diverticula, varicosities, cardiospasm, and scleroderma. Most of these lesions are illustrated.

The article is heartily recommended to anyone desiring a concise review of roentgenology of the esophagus.

Twenty roentgenograms. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Diagnosis and Preoperative Management of Congenital Esophageal Atresia and Tracheo-Esophageal Fistula. Osler A. Abbott and William A. Hopkins. J. M. A. Georgia **40:** 44–59, February 1951.

The authors believe that with early diagnosis, proper preoperative care, and appropriate surgery, 80 per cent of infants with esophageal atresia and tracheo-esophageal fistula may be salvaged. The frequency of associated anomalies makes any considerable increase in this percentage doubtful.

Vogt's classification is repeated:

I. Agenesis
II. Atresia with no communication with the trachea
III. Atresia with fistula
  (a) Fistula between the proximal segment and the trachea; distal segment ending blindly
  (b) Fistula between distal segment and trachea, or rarely a main bronchus; proximal segment ending in a blind pouch
  (c) Communication of both proximal and distal segment with trachea

To these may be added the so-called H-type of fistula, such as occurs in the absence of atresia.

The symptomatology varies with the age of the patient and the type of anomaly. In general the significant symptoms are as follows: difficulty in resuscitation at birth with cyanosis persisting beyond the first hour of life; excessive salivation; difficulty associated with the earliest attempt at feeding, noted either as immediate vomiting or associated cyanosis; secondary pulmonary complications such as atelectasis and pneumonia, which appear with increasing frequency with increase in age of the infant; dehydration in children over five days of age; abdominal distention when the lower esophageal segment commu-

nicates with the trachea. Infants with an H-type fistula without atresia may present a different type of syndrome.

When a congenital anomaly is suspected, a soft catheter should be passed into the esophagus under fluoroscopic guidance. This tends to meet a characteristic obstruction at about the level of the second dorsal vertebra and bend back upon itself. If desired, a small amount of lipiodol (never barium) may be introduced through the catheter, after cleansing of the upper esophageal pouch. The size and mobility of the upper pouch are best studied fluoroscopically. In those cases without atresia the oil should be injected with the patient face down. Since fistulae of this type are usually high in location, the catheter should be withdrawn to the level of the first dorsal vertebra before injection of the iodized oil. Plain films will show air in the gastro-intestinal tract in the presence of a fistulous communication between the trachea and distal esophageal segment. When the lower pouch ends blindly, there will be no gas in the intestine.

Great stress is laid on preoperative preparation, and the operative procedures are discussed.

The authors report a series of 20 cases. Among the last 12 operative cases there were 9 survivals. Two patients in the series had recurrences, one of which proved fatal. Except for 2 cases in which severe cardiac anomalies were present, all deaths were due to overwhelming pulmonary infection.

Three roentgenograms; 2 photographs; 1 drawing.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Spontaneous Rupture of the Esophagus. M. Eugene Flipse. Dis. of Chest **19**: 165–189, February 1951.

Under the heading spontaneous rupture of the esophagus are included two groups of cases: one with rupture or perforation due solely to an increase in the intra-esophageal pressure greater than the tensile strength of the wall; and second, those with clinically silent inflammations, ulcerations, and softening, tending to weaken the wall and thus predispose to rupture. It does not include cases in which there is clinical or gross pathological evidence of pre-existing disease or of trauma.

Any increase in intra-esophageal pressure must be secondary to increased intra-abdominal pressure, transmitted by the stomach contents through the cardia. Whether the pressure reached will be sufficient to rupture the esophagus will depend upon the strength of the esophagus and the intensity of the increased pressure. This latter depends, in turn, upon the rapidity and magnitude of the increased intra-abdominal pressure, the amount of stomach contents, and the patency of the cardia and the esophagus.

Vomiting and retching are the most important causes of sudden increased intra-abdominal pressure. These occur often with chronic alcoholism and diseases of the central nervous system. Pressure increases great enough to rupture the esophagus have also occurred with straining associated with defecation lifting, convulsions, and from blunt trauma to the abdomen. Esophagitis, ulcer, or esophagomalacia may weaken the esophageal wall and so predispose to rupture.

The transmitted force of sudden increased intra-abdominal pressure can produce significantly increased intra-esophageal pressure only if the contents of the stomach *cannot* be expelled through the esophagus as rapidly as they leave the stomach. This disproportion between esophageal filling and emptying can occur either because of distention of the stomach with food or fluid or because of esophageal obstruction.

Because there are no evidences of mechanical obstruction in most cases, physiological obstruction is postulated at the narrowed part of the esophagus, namely, its junction with the pharynx. Here the pharyngeal and upper esophageal muscle fibers fuse to form a sphincter. These muscle fibers, like those of the diaphragm, are striated and have motor innervation, while the lower portion of the esophagus and remainder of the gastro-intestinal tract have smooth muscle fibers, with innervation through the autonomic nervous system. This difference in innervation and muscle type predisposes to inherently greater tonicity of the striated muscles at all times and to actual spasm during any generalized motor discharge such as occurs during the convulsions of epilepsy or intracranial disease.

Vomiting is a complex reflex act requiring the synchronous relaxation and/or contraction of many voluntary and involuntary muscles. Incoordination of the vomiting reflex resulting in physiological obstruction in the upper esophagus could favor a rupture of the esophagus.

The esophageal tear is usually single and longitudinal, just above the cardia, in the left posterolateral wall. The clinical picture varies somewhat depending upon whether it occurs in a previously normal person, postoperatively, or in a neurosurgical patient. If a rupture is suspected, it can be verified by observing the passage of a radiopaque substance through the esophagus into the mediastinum or pleural space. The radiologic findings vary depending on the course taken by the rupture. The earliest finding is usually a mediastinal emphysema, later extending into the neck and subcutaneous tissues. There may be a massive rapidly increasing hydropneumothorax. A hydrothorax without air is occasionally seen, secondary to mediastinitis. Verification with barium or iodized oil should always be made before treatment is instituted.

Two case histories are included.

Two roentgenograms; 1 table.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Persistent Vomiting Due to Cardio-Oesophageal Relaxation in Infancy. Peter H. Spohn and C. Gordon Campbell. Canad. M. A. J. **64**: 126–128, February 1951.

The authors report a case which they diagnosed as chalasia (cardio-esophageal relaxation) in an infant one month old, on the basis of persistent vomiting since birth and radiographic evidence of excessive reflux of barium from the stomach into the esophagus. After the diagnosis was made, the child was given a thicker formula (milk, water, and Pabena) and held upright for forty minutes after feeding. He was also kept in a sitting position in bed. He gained weight satisfactorily after the beginning of this regime, having previously gained poorly. At five months the child was still receiving a partially thickened formula but no longer had to be held upright after feeding. Two roentgenograms of the barium-filled esophagus and stomach are presented.

Two roentgenograms; 1 chart.

T. FREDERICK WEILAND, M.D.
Jefferson Medical College

Cancer of the Stomach. Stanley E. Lawton, Charles E. Fildes, and Leon Seidman. Am. J. Surg. **81**: 221–226, February 1951.

This paper presents an analysis of 1,004 patients with cancer of the stomach admitted to Hines Hospital (Illinois) during the years 1931 to 1947, inclusive. The hospital serves as a tumor center and receives large numbers of cancer patients from an extensive area. These patients come from many states, are of different social backgrounds, and have had available services ranging from those of the most rural practitioner to those of the highly trained medical center specialist. The study may be considered to represent, therefore, a cross-country view of what is happening to the 38,000 persons doomed to die annually from cancer of the stomach. Follow-up reports are available on practically 100 per cent of the patients.

The average age for the entire series was 50.6 years. This low average compared with 1940 census figures for the entire United States is explained by the fact that the patients at Hines Hospital are largely veterans of World War I who are only now attaining the age at which cancer of the stomach can be expected to occur more frequently. On physical examination 48 per cent of the patients had a palpable tumor and 39 per cent were cachectic, both manifestations of pathologically advanced disease. An average of nineteen months elapsed before the onset of gastro-intestinal symptoms and admission of these patients to the hospital. Approximately 30 per cent had been treated for ulcer at some time during the course of their disease, and 75 per cent of these obtained relief from pain.

Definite anemia with hemoglobin readings below 70 per cent was found in 271 cases (30 per cent), and blood smears showed the presence of pernicious anemia in 3 per cent of the cases. Stool examinations for occult blood, done in 954 patients, were positive in 95 per cent. Early, small lesions as well as advanced carcinomas produced positive benzidine reactions. Probably the most valuable of all laboratory findings is the absence or decrease of free hydrochloric acid in the gastric juice. Gastric analysis was carried out in 792 cases. Achlorhydria or hypochlorhydria was found in 665 (84 per cent), normal acidity in 87 (11 per cent), and hyperacidity in 40 (5 per cent).

Eight hundred and one of the patients in the series were examined fluoroscopically and roentgenographically. In 793 (99 per cent) a lesion of the stomach was found; in 8 cases the x-ray findings were reported as negative. In 737 patients, the diagnosis was malignant growth, in 32 benign ulcer, and in 20 an unspecified type of growth.

Three hundred and seventy-six of the patients entered the hospital with no chance of being cured, because of the extensiveness of their tumors at the time of the admission. Of the 628 remaining, who were deemed operable, 309 proved to have cancer advanced to a degree which limited operative procedures to exploration and palliation, leaving 319 patients upon whom gastric resection could be performed. A postoperative mortality of 54 (17 per cent) further reduced the number of possible cures to 265. Thus, of a total of 1,004 patients, approximately only 1 in 4 was in physical condition at the time he entered the hospital to undergo and survive gastric resection.

Patients considered inoperable and given only supportive treatment died within 4.5 months. Those who were explored lived on an average of seven months; in cases in which gastro-enterostomies and jejunostomies were done, and the patient left the hospital, the average survival time was 8.5 months. The patients with resections, now dead, lived an average of 3.5 years, and those with resections who are still living have averaged 4.5 years survival since operation.

The authors emphasize the value of periodic x-ray examination of those known to be prone to develop gastric cancer, namely, all patients with achlorhydria or hypochlorhydria, all patients with pernicious anemia, and all patients with occult blood in the stool.

Three charts; 1 table.

High Diverticula of the Stomach. H. R. Beck. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 47–59, January 1951. (In German)

Gastric diverticula are rare. Nauwerck found only two examples in 15,000 autopsies; radiologic statistics seem to point to a somewhat higher incidence. Beck describes 4 cases in the cardiac portion of the stomach which he observed personally and discusses them in detail, with regard to pathogenesis and differential diagnosis. A special form of niche-like dilatation of the mucous membrane of the posterior wall of the stomach is mentioned, with marked changes in size and configuration, and even complete disappearance, in the course of follow-up examinations. This is attributed to the autoplastic character of the gastric mucosa and the term "autoplastic pseudo-diverticulum" is suggested for the entity. The differential diagnosis between gastric ulcer and high diverticulum of the stomach is considered in detail.

Thirteen roentgenograms.

ERNST A. SCHMIDT, M.D.
Denver, Colo.

Case of Gastric Actinomycosis. H. G. Schmitt. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 110–112, January 1951.

In a patient who about five months previously had been operated upon for a suspected liver abscess, the roentgenogram showed extensive deformity of the prepyloric region of the stomach combined with marked infiltration of the gastric wall and rigidity of outlines. A preliminary diagnosis of carcinoma was made and an exploratory laparotomy was advocated. During operation a large tumor was found involving the anterior wall of the stomach, transverse colon, mesocolon, and parts of the omentum. Pathologic examination showed typical actinomyces granulation with abscess formation and fistulae. There was no evidence of malignancy, and the patient is well six years after operation.

One roentgenogram. ERNST A. SCHMIDT, M.D.
Denver, Colo.

Prolapsing Gastric Mucosa. David B. Corcoran and K. K. Wallace. Virginia M. Monthly **78**: 32–37, January 1951.

Prolapse of redundant gastric mucosa is a not infrequent cause of gastro-intestinal distress. Symptoms vary from vague discomfort to pain, nausea and vomiting, and even hemorrhage. On microscopic examination the redundant mucosa is always hyperemic, with extravasated blood in the tissue spaces.

The characteristic x-ray picture consists of a central mushroom- or cauliflower-like negative shadow located at the base of the duodenal bulb, the so-called "umbrella

sign." This deformity is characterized by variability, frequently presenting a different appearance during the same examination and almost without exception showing some change when the examination is repeated on a different occasion. At one time the duodenal bulb may be almost filled with a non-opaque intraluminal protrusion and at another only a small portion of the bulb adjacent to the pylorus may be involved. Quite often the redundant mucosa can be traced from the antral canal through the pyloric opening into the base of the bulb.

Conservative management (ulcer regime) is sufficient to relieve the symptoms in most cases but sometimes pyloroplasty or subtotal gastric resection is necessary.

Nine cases are reported with representative films in seven. Two of the group were proved by surgery.

Seven roentgenograms; 2 photographs.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Chronic Peptic Duodenal Ulcer with Cancerous Transformation. E. F. Geever, V. L. Bolton, and N. W. Fawcett. Am. J. Digest. Dis. **18**: 61–63, February 1951.

Malignant change in peptic ulcer is unusual. Ewing found 10 instances in a review of the literature to 1940. The authors add a case which is unusual in that it was unsuspected even on gross pathologic examination.

The patient, a 74-year-old female, entered the hospital because of symptoms which failed to respond to dietary management. X-ray examination four years earlier had revealed a duodenal ulcer and a non-functioning gallbladder. There had been a 14-pound weight loss in the last three months.

Roentgen studies revealed a poorly functioning gallbladder with a single stone and a large duodenal ulcer. The stomach was markedly dilated and there was 100 per cent retention after two hours. Medical management was tried over a period of five months, but lasting improvement was not obtained, and a jejuno-jejunostomy was performed. Death occurred suddenly eighteen hours later. At autopsy a large duodenal ulcer was found, which on microscopic study was shown to be malignant.

The authors speculate as to whether this was malignant from the time of the original diagnosis four years before or whether it represents carcinomatous change in a benign ulcer.

Two roentgenograms; 2 photomicrographs.

JOSEPH T. DANZER, M.D.
Oil City, Penna.

Vagotomy in the Treatment of Duodenal Ulcer: Results in Three Hundred and Fifty Consecutive Cases. Joseph Weinberg, Alvin R. Kraus, Stephen J. Stempien, and Franklin B. Wilkins. Arch. Surg. **62**: 161–170, February 1951.

The authors summarize their experience with 350 cases of duodenal ulcer treated by bilateral vagotomy and followed for six to forty-five months. They discuss their results under seven headings:

1. Results as judged by roentgenologic examination.
2. Results according to the effect of the vagotomy on the primary indication for surgical treatment.
3. Patients with persistent ulcer symptoms who have undergone what is considered an adequate vagotomy.
4. Postoperative responses to insulin.
5. Opinions of the patients regarding the value of the operation.
6. Undesirable side-effects.
7. Deaths.

These criteria give an over-all picture of the results. To radiologists the most important are the results as judged by roentgenologic examination. In this series of 350 patients, 348 had postoperative roentgenographic examinations of the gastro-intestinal tract in an attempt to determine not only the status of the ulcer but also the completeness of the vagotomy. The latter was judged by the gastric peristalsis, motility, tone, and size compared with the preoperative observations. It was concluded that the vagotomy was adequate in 314 of the patients and inadequate in 34. The following findings are recorded:

Duodenum visualized	235
Presence of ulcer crater with recurrence of symptoms	6
Presence of crater with no symptoms	5
Duodenum not filled sufficiently to determine presence or absence of crater	102

Of interest to the radiologist also are the undesirable side-effects of vagotomy, since some of these are determined radiologically. In their earlier cases, before gastro-enterostomy or pyloroplasty was routinely combined with vagotomy, retention was one of the commonest undesirable side-effects. Since the latter procedures have been adopted, there has been little difficulty in this respect. As time passes from the date of operation, there is a return toward normal gastric motility and tonicity.

Cardiospasm was demonstrated roentgenographically in a few cases.

Eight tables.

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Transit Time Through the Small Intestine. A Roentgenologic Study on Normal Variability. Lars Lönnerblad. Acta radiol., Suppl. 88, 1951.

The work described in this monograph was carried out in an effort to determine the transit time for barium in normal persons and to secure data concerning the variability of this time in different individuals and in the same individual on different occasions. No adequate normal series seems to have been previously studied by a uniform method.

The test subjects were: (*a*) 43 children 9 to 18 months of age; (*b*) 163 children 9 to 10 years of age; (*c*) 114 adults 18 to 25 years. No persons with gastro-intestinal complaints were included. Fasting was required for eight hours before the tests.

Barium sulfate in distilled water, flavored with sodium saccharine, was used as the contrast medium. The 1-year olds were given 55 ml.; the children of 9 to 10 years, 110 ml.; the adults, 200 ml. The patients were asked to lie on the right side, and the progress of the meal was followed both roentgenographically and fluoroscopically at half-hour intervals until the ileocecal valve was passed.

The transit time was reckoned from the time when the subject finished drinking the contrast meal. Precautions were taken not to confuse the coiled up terminal

leal loops with the cecum. The mean transit times for each group were as follows: 2¾ hours for 1-year olds, 2½ hours for 9- to 10-year olds, and 3 hours in 18- to 25-year olds.

Transit times of thirty minutes and less were observed. It was also found that a small amount of contrast medium takes longer to pass the small intestine than a larger amount in the 9- to 10-year-old group. Variations in transit time in each group were attributed to errors in measurement or to individual differences due to various states of stimulation. Emotional factors did not seem markedly to influence the transit time.

Observations were made regarding the pattern, segmentation, and other appearances of the small bowel. It was found that segmentation indistinguishable from so-called "deficiency patterns" was present in normal subjects. In some adults fluid levels up to 3 cm. broad were observed.

The author gives a comprehensive statistical analysis, for which the original article should be consulted.

Fifty-seven roentgenograms; 18 tables; 2 illustrations.

ELMER F. WAHBY, M.D.
The Henry Ford Hospital

Incomplete Obstruction of the Small Intestine. Alexander Strelinger. Am. J. Digest. Dis. **18:** 66–70, February 1951.

A series of 6 cases of partial bowel obstruction are described by the author in order to bring into focus four points: (1) that the symptoms are not definite, and will vary a great deal; (2) that the obstruction may escape roentgen diagnosis; (3) that the diagnosis of probable obstruction may in some cases be made on the basis of clinical signs; (4) that permanent relief by surgical intervention can be obtained in non-malignant cases.

The difficulty encountered in these cases was chiefly that of diagnosis. The author quotes Kiefer (New York State J. Med. **44:** 2342, 1944) stating that ". . . certain limitations of roentgenologic diagnosis must be kept in mind. Since narrowing of the lumen of the small bowel may cause no delay until obstruction is almost complete, intermittent small bowel obstruction, particularly when caused by bands of adhesions, may not be evident roentgenologically unless the examination is made in the presence of obstruction. In suspicious cases, if possible, the patient should be examined during an attack even if only by plain film of the abdomen, in the upright position, so as to show fluid levels in the distended loops."

Another method of visualizing the small bowel is to pass a catheter beyond the duodenum and fill the small bowel with barium. This is said by the author sometimes to show details that cannot be identified by any other method.

Six roentgenograms.

JOSEPH T. DANZER, M.D.
Oil City, Penna.

Radiological Experiences in True Strangulating Obstructions. J. Frimann-Dahl. Acta radiol. **35:** 85–100, February-March 1951.

Among 410 cases of intrinsic small intestinal obstruction there were 60 cases of true strangulation. There are two varieties of mechanical obstruction, the simple occlusions and the real strangulations. In simple occlusions only one portion of the gut is involved by intrinsic or extrinsic compression of the lumen, and the continuity alone is blocked. In true strangulations two loops of the bowel are occluded. The classical signs of the former are fluid levels in more or less hoop-shaped loops above the area of stenosis, and little or no gas distal to the obstruction.

The roentgen diagnosis of real strangulation presents more of a problem. There may be rather long fluid levels with restricted movements. The imprisoned loops are distended mainly by fluid, and the prestenotic loops more distended by gas. The amount of free fluid in the peritoneal cavity is more abundant in strangulating than in simple obstructions.

The use of barium by mouth is advocated to aid in differentiating the two types of obstruction. In strangulating obstructions, there is a tendency to delay in the passage of the medium, which is retained in the stomach and the upper jejunum, a sign more frequently observed in complete than in partial obstructions. However, if the contrast material passes down to the point of obstruction, the prestenotic loops of bowel may be displaced by the tumor-like filling of the incarcerated loop.

The severity of an ileus cannot be estimated from the number and size of the fluid levels. On the contrary, the most severe cases of strangulation show only a small amount of gas and a few short fluid levels. Distal to the stenosis the small and large intestine is always found collapsed and devoid of gas and fluid, though small amounts of gas in the large bowel do not rule out the presence of a strangulation of the small intestine.

In cases in which urography was performed to rule out a ureteral stone there was slight compression of the ureters in the lesser pelvis and also a compression of or a wave-like impression upon the bladder by the tumor-like coil of the incarcerated loops.

Thirteen roentgenograms.

SHOZO IBA, M.D.
Cleveland City Hospital

Pseudopolyposis Lymphatica Ilei (Pseudo-ileitis). J. Bücker and H. R. Feindt. Fortschr. a. d. Geb. d. Röntgenstrahlen **74:** 59–65, January 1951. (In German)

The authors describe in detail 5 cases in which the radiologic appearances of the terminal ileum corresponded to the picture described as non-sclerosing ileitis by Golden, Strömbeck, and Prévôt. In only one of these was ileitis the clinical diagnosis. In the second case, also, gastro-intestinal symptoms were predominant, but in the remainder complaints referable to the alimentary canal were insignificant. Experimental studies are cited in which fasting animals showed small lymph nodes with few cells, while well nourished animals exhibited large polypoid relief of the terminal ileum. In view of these observations, it is concluded that a polypoid appearance of the ileum cannot be considered a definite sign of ileitis. It may be due solely to hyperplastic lymph follicles and be found in children and young people in good nutrition without evidence of intestinal disease.

Five roentgenograms; 1 photograph.

ERNST A. SCHMIDT, M.D.
Denver, Colo.

Pseudocysts of the Pancreas. Kenneth B. Brilhart and James T. Priestley. Am. J. Surg. **81:** 151–160, February 1951.

Pseudocyst is the most common cystic lesion occurring in association with the pancreas. Character-

istically, a patient who has a cyst of this type presents a history suggestive of recurring pancreatitis and a rounded mass somewhere in the upper part of the abdomen. The mass may change in size or at times disappear entirely between attacks of abdominal pain. Occasionally pain is absent or minimal. Roentgenologic study may reveal significant or contributing evidence of pancreatic disease. In 16 of the 44 cases of pseudocyst of the pancreas seen at the Mayo Clinic during the years 1935–1947, a soft-tissue mass was noted in the upper part of the abdomen. Six patients had evidence of calcification in the region of the pancreas. A non-functioning gallbladder was diagnosed in 6 cases and stones were found in the gallbladders of an additional 3 patients. Holt (Radiology **46:** 329, 1946) emphasized the diagnostic importance of widening of the duodenal loop as a sign of a cyst located at the head of the pancreas. Displacement of the stomach or indentation of the greater curvature may be caused by a cyst in the body or tail of the pancreas, although these findings are not pathognomonic of pancreatic cyst.

Incision and drainage, with or without marsupialization, are considered the treatment of choice. Cysts recurred in only 3 of the 31 cases in which treatment of this type was employed; in each of these 3 instances it appeared that an inadequate period of drainage had been maintained. Total excision of the cyst or an anastomosis between the cyst and some part of the intestinal tract is recommended only in exceptional cases.

Two roentgenograms; 1 photograph.

Liver and Spleen Visualization by a Simple Roentgen Contrast Method. Samuel Zelman. Ann. Int. Med. **34:** 466–478, February 1951.

Definitive visualization of the liver and spleen has been attempted by such technics as pneumoperitoneum and intravenous thorotrast injection. The first method is traumatic; the second is considered dangerous due to long continuing radioactivity and possible undesirable effect of blocking the reticulo-endothelial system.

The method described here involves none of these objections. It is routinely applicable, essentially free of trauma, and without danger. Gastro-intestinal bleeding and perforation are considered the only contraindications. It is essentially an improvement of the ordinary abdominal flat plate roentgenographic study in which the occasionally helpful gas shadows are deliberately reinforced. Over 140 of these examinations have been performed thus far, with no ill effects other than a rare complaint of mild abdominal cramping.

The examination is best performed with the stomach empty, though this is not essential. Colonic preparation is not needed. The patient is given one-half to one Seidlitz powder mixture in separate one-third glassfuls of water and asked to retain the stomach gas without belching until the roentgenograms have been made. The drink is followed immediately by injection of air into the colon by rectal tube and bulb, continued until the patient is aware of a feeling of fullness; greater distention than this is not necessary. The patient also holds this air until completion of the examination.

Roentgenograms are made in the standing position, with the postero-anterior view for optimal liver visualization and the left oblique view for optimal spleen visualization. Left oblique views, at approximately 30 degrees, have also been found satisfactory. Films are exposed at 40-inch distance, in the expiratory phase of respiration. An upright Bucky grid is used, with an exposure time of one-half second at 100 ma., the kilovoltage varying with body thickness (usually 65 to 75 kv. for the postero-anterior with an additional 5 kv. for the oblique view). The central ray is directed through the midepigastrium (eleventh or twelfth dorsal vertebra).

It is the author's practice to designate the size of the liver and spleen as small or normal, or slightly, moderately, or greatly enlarged. Measurements may be of value, particularly in serial studies. The shape and position of the liver and spleen are also observed and sometimes yield diagnostic clues. Not infrequently, other findings of interest are noted in the films. Prominent among these have been calcifications within the spleen, liver, gallbladder, pancreas, and kidneys. Outlines of the kidneys are usually easily discernible. The visualization procedure occasionally has been of aid in the localization of abdominal tumors.

In the author's experience clinical palpability as a method of estimating liver and spleen enlargement has been in error in a surprisingly high percentage of cases. Errors occurred in both directions, *i.e.*, palpable organs were often not enlarged, and enlarged organs frequently were not palpable. The degree of development and tension of abdominal musculature, width of the costal angle, nutritional state, position of the diaphragm, and other factors may account for this discrepancy. The author is impressed particularly by the high incidence of palpable livers depressed by the low diaphragms and wide costal angles of emphysema. The high-lying transverse type of spleen may be enlarged, yet not extend below the costal margin, whereas the low-lying lateral spleen may be palpable when of normal size.

A similar method of visualizing the liver and spleen was suggested in 1914 by German authors, but was later abandoned in favor of pneumoperitoneum. Improvements in roentgen technics since that date, particularly the use of the Bucky grid, are responsible for the better radiographic visualization now obtainable, and obviate the fluoroscopic observation required by the earlier workers.

Fourteen roentgenograms.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Intramural Diverticulosis of the Gall Bladder. Case Report. L. Glücker. Acta radiol. **35:** 133–136, February-March 1951.

Although diverticulosis of the wall of the gallbladder has been known since the 17th century, the first reports on radiographic visualization of the diverticula did not appear until 1948. The case presented here, in a 57-year-old woman, is said to bring the number of reported cases thus demonstrated to four. Conditions which must be present for demonstration of the diverticulosis during cholecystography are good contrast filling of the gallbladder and diverticula of sufficient number and size, empty and wide-necked enough to allow contrast material to enter.

Two roentgenograms. NELSON E. KLAMM, M.D.
Cleveland City Hospital

Cholecystitis Emphysematosa. Carl F. Qvist. Acta radiol. **35:** 200–206, February-March 1951.

Cholecystitis emphysematosa is a gallbladder infection accompanied by the formation of gas in the gall-

bladder and sometimes in the biliary tract as well. The author tabulates 24 cases previously reported and adds one of his own, in a 63-year-old man who recovered following cholecystectomy.

Clinically the condition is indistinguishable from cholecystitis without gas formation. Most of the cases appear to have been caused by anaerobic bacteria or those of the coli group. Seven of the 25 reported cases occurred in diabetics.

The roentgen findings are practically pathognomonic, consisting of a gas shadow, corresponding in size and position to an enlarged gallbladder, surrounded by a darker concentric annular shadow representing gas in the gallbladder wall. The biliary ducts may contain air and in later stages gas is seen in the pericholecystic tissues.

One roentgenogram.

DONALD F. MAURITSON, M.D.
Cleveland City Hospital

Studies on the Hepatic Ducts in Cholangiography. Olof Norman. Acta radiol., Suppl. 84, 1951.

The author describes the cholangiographic technic employed at the University Clinics, Lund, Sweden, and reports his observations in a series of cases. With high-capacity x-ray equipment to permit short exposure times, a water-soluble contrast medium, and careful co-operation between the anesthetist, surgeon, and radiologist, cholangiograms are made in the operating room during operation on the biliary system. The common hepatic duct is cannulated with a special blunt needle and the contrast medium is injected in a retrograde manner. Four films are taken from varying angles so that superimpostion of the hepatic branches is avoided. Exposures are not made during the injection, since motion of the fluid within the ducts may cause a filling defect to be obscured.

For proper interpretation of the films, the anatomy of the main biliary trunks must be understood. The author describes a left main tributary branch to the hepatic duct extending in a left-cranial-ventral direction, a right anterior branch extending to the ventrocranial and intermediate segments of the right lobe of the liver, and a right posterior branch which has a pronounced curvature. The left branch has a wider lumen than the other two. Numerous variants in respect to position and division are described and illustrated.

Operative cholangiography is of practical importance. The radiologist is able to tell the surgeon if a branch of the biliary tract lies in such a position within the operative field that it might be inadvertently injured. Stones which might otherwise be overlooked are recognized in the various branches and may be promptly removed.

Cholangiography was done on 919 patients, in 46 of whom stones were found. In 37 cases the stones were seen on the operative cholangiogram and in the remaining 9 cases on the postoperative cholangiogram. In the latter group review of the initial operative cholangiogram showed that the stones were present at that time but not recognized. In 19 of the 37 cases all of the stones could be removed at the time of surgery. In 40 cases, the stones were in the left branch of the hepatic duct.

Analysis of the roentgenograms must take into consideration the common hepatic duct, the three main branches of the hepatic duct, and the smaller intrahepatic ducts. Filling defects in these structures may be due to stones, air bubbles, mucous floccules, blood clots, or tumor. Air bubbles are differentiated by their changing size and shape on the different films. Mucous floccules present irregular and elongated negative shadows. Blood clots appear as long molded negative densities. Tumor often appears as an irregularity along the wall of the duct. Incomplete filling of the entire biliary tree cranially to the tip of the cannula is probably due to mechanical obstruction by the cannula. Incomplete filling of a single branch of the tree is strongly indicative of some obstruction such as a stone blocking the branch.

Sixty-six roentgenograms; numerous diagrammatic illustrations and tables.

RICHARD F. MCCLURE, M.D.
The Henry Ford Hospital

Benign Stricture of the Intrahepatic Bile Ducts. R. Franklin Carter and Lee Gillette. J. A. M. A. **145:** 375–379, Feb. 10, 1951.

The authors discuss the observations, treatment, and follow-up in 15 cases of benign stricture of the intrahepatic ducts seen over an eight-year period. This entity, although a frequent cause of biliary cirrhosis, has received little surgical attention. In the cases reported here the condition was detected either by probing into the hidden portion of the hepatic ducts or by use of the immediate cholangiogram. The discovery of intrahepatic stricture has clarified the preoperative diagnosis of biliary obstruction in those patients previously given a diagnosis of biliary obstruction in whom no lesion could be found.

The clinical picture of benign stricture of the intrahepatic bile ducts is that of an obstructive jaundice. Preoperative and postoperative cholangiograms are useful in establishing the diagnosis.

The simplest treatment is dilatation of the strictured area and the insertion of an obturator (T tube) to prevent shrinkage. Following the application of this procedure, 11 of the 15 cases reported were classified as having good results; in 2 the results were questionable, and in 2 poor.

Judging from the lack of reports of intrahepatic stricture in the literature, the authors' experience of 15 cases should be a beginning of the separation of cases of biliary cirrhosis of indeterminate causation. They urge that operative cholangiography be performed in cases of obstructive jaundice.

Four roentgenograms; 1 drawing; 5 tables.

ROBERT H. LEAMING, M.D.
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THE MUSCULOSKELETAL SYSTEM

Paget's Disease Complicated by Hyperparathyroidism. Howard Rosen. Bull. Hosp. Joint Dis. **11:** 113–127, October 1950.

This paper is presented to re-emphasize the separate identity of Paget's disease and hyperparathyroidism, to point out the similarities that have caused their confusion, and to show that their simultaneous occurrence in one individual is purely fortuitous and merely represents the coincidental association of the two entities. The differences between the two diseases are enumerated as follows:

Paget's Disease: (1) Occurs in older people, usually males. (2) Sarcoma of bone may develop. (3) Fracture rarely occurs spontaneously in the soft bones of early

stages. (4) Renal calculi are the exception. (5) Bowing of the bones and a thickened cortex are characteristic. (6) There is no change in the serum calcium or inorganic phosphorus. (7) Usually there is no increase in the excretion of calcium and phosphorus; when it does occur, they are excreted in increased amounts in both urine and feces. (8) No tumor of the neck or epulis tumor of the mouth is seen.

Hyperparathyroidism: (1) Occurs in all age groups, commonly in females. (2) Rarely, if ever, does sarcoma develop. (3) Fractures often occur in the brittle bone. (4) About 85 per cent of the patients have nephrolithiasis or nephrocalcinosis. (5) Thin cortices, bone cysts, and "brown tumors" are characteristic. (6) Hypercalcemia with hypophosphatemia is almost pathognomonic, and as a result of these, gastro-intestinal and other symptoms occur. (7) There is a marked increase in the excretion of calcium and phosphorus in the urine, but no increase in their fecal excretion. The high urinary excretion accounts for the elevated incidence of renal calculi, and the frequent occurrence of polyuria and polydipsia. Sometimes the latter is so severe as to simulate diabetes insipidus. (8) A palpable tumor of the neck occurs in 10 per cent of cases, and epulis tumors are common.

The roentgenographic appearance of the skeleton in Paget's disease and hyperparathyroidism also differs quite markedly.

Paget's Disease: (1) Increased coarseness and irregularity of the trabeculae in usually enlarged or hyperostotic bones. (2) Greatest severity in the weight- and stress-bearing bones, *i.e.*, highest incidence in the sacrum. (3) Usually no "brown tumors" or cysts. (4) Skull thick, with a moth-eaten appearance; "osteoporosis circumscripta" occasionally seen. (5) No changes in the lamina dura.

Hyperparathyroidism: (1) Sparse, irregular trabeculae in a usually osteoporotic skeleton. (2) No predilection for any particular bone; generalized osteoporosis. (3) Scattered cysts, especially in the cortices, in 40 per cent of cases. "Brown tumors" and pseudocysts occur often and appear as cysts, too. (4) Skull finely granular, with so-called "ground glass" appearance, with occasional interspersed areas of rarefaction and indistinct diploe; thickness of the calvarium unaffected. (5) Absence of lamina dura in the tooth sockets (a manifestation of the generalized decalcification).

A proved case of hyperparathyroidism and Paget's disease occurring in the same individual is reported.

Two roentgenograms; 2 photomicrographs; 1 chart.

Multicentric Osteogenic Sarcoma in Paget's Disease with Cerebral Extension. Herbert Derman, Phillip Pizzolato, and Joseph Ziskind. Am. J. Roentgenol. **65:** 221–226, February 1951.

The incidence of osteogenic sarcoma associated with Paget's disease has been previously reported as from 5 to 14.4 per cent. The sarcoma may occur in multicentric foci, which are not considered metastatic. Malignant involvement of the skull is relatively rare. Intracranial involvement has been reported 7 times, but cerebral extension only twice. An original case of extension to the cerebrum is presented here.

A white male, 57 years old, was first seen in April 1948, having incurred a fracture of the right femur one week previously incident to slipping on the bathroom floor. He had been well until 1926, at which time he sustained a fracture of the left humerus as a result of minimal trauma. Healing was uneventful, but four years later a second fracture was incurred 4 inches distal to the first. A bony mass at the site of the previous fracture was noted, but diagnosed as an excessive calcium deposition. Nine years following the second fracture the right humerus was fractured, again as a result of minimal trauma. Multiple roentgenograms showed bone changes characteristic of Paget's disease. The next year (1940) bowing of the lower extremities was noted. In July 1947, the left humerus was again fractured. The patient was hospitalized, a diagnosis of osteogenic sarcoma of the left humerus was made by biopsy, and the arm was amputated. Two months prior to the final hospitalization, a firm, non-tender, nonmovable mass was noted over the right frontal region, which rapidly enlarged to 3 inches in diameter. The patient died on the twelfth hospital day.

Roentgenograms of the humeri had revealed Paget's disease, more pronounced on the right. There was a fracture through an area of extensive osteolysis in the subtrochanteric segment of the right femoral shaft. The remainder of the femur showed extensive Paget's disease.

At autopsy the frontal tumor was found to have involved the right parietal and right frontal bones and invaded the underlying dura and brain. The skull was irregularly thickened and spongy, presenting many additional punched-out, tumor-filled lesions, varying from 0.3 to 2.0 cm. in diameter. The histopathological picture of the tumors both in the skull and femur was that of osteolytic osteogenic sarcoma.

Coley and Sharpe reported 71 cases of osteogenic sarcoma in persons over fifty years of age, of which 20 (28.1 per cent) were associated with Paget's disease. Such findings suggest more than a coincidental relationship and emphasize the likelihood of underlying Paget's disease in osteogenic sarcoma occurring after the age of fifty. It is generally reported that Paget's disease is present for a considerable time before the onset of sarcomatous change. The duration is usually considered to be from ten to fifteen years. The longest period reported was thirty-five years. In the case presented here it was at least eight years.

One roentgenogram; 10 photographs and photomicrographs.

HOWARD B. BURNSIDE, M.D.
University of Arkansas

A Contribution to the Differential Diagnosis of Bone Calcification, Especially of the Bony Infarct. A. Jakob. Fortschr. a. d. Geb. d. Röntgenstrahlen **74:** 77–83, January 1951. (In German)

The diagnosis of bony infarcts is of relatively recent date. Until a few years ago, calcifications in the bones were generally diagnosed as calcified enchondromas, interosseous calcified parasites, unusual forms of central osteomyelitis, or degenerated calcified islands of cartilage; occasionally sclerosing osteogenic sarcoma or osteoplastic metastasis came under consideration in the differential diagnosis. Bony infarcts probably escaped clinical recognition for so long a time because the interruption of the circulation in the bones (which is the primary cause) practically never produces complaints, and bone autopsies and bone operations are, relatively speaking, rarely done. Furthermore, the calcifications are late manifestations and consequently are often con-

fused with other chronic lesions, especially joint affections. If the medullary necrosis which is the immediate result of an infarct involves only a small bone area, it is probably repaired by new bone in a short time and cannot be visualized radiologically. Only larger necrotic areas manifest themselves by visible medullary calcifications, which may assume striated, trabeculated, annular, and polycyclic "spotty" forms.

Bony infarcts may occur as single or multiple lesions. The former are most often seen in stenosing arteriosclerosis, endarteritis obliterans or thrombosis and embolism. The latter type has so far been most frequently observed in caisson workers. Anemia seems to be a predisposing factor. Multiple bony infarcts have been described in sickle-cell anemia.

The author presents 4 cases diagnosed and observed during a period of two years, as well as 2 cases seen previously. In 3 of these cases, the x-ray findings were incidental; the chief complaint of the patients was uncharacteristic pains in the limbs. In the fourth case the calcifications were seen in roentgenograms of the skeleton in the search for the cause of obscure anemia. The clinical diagnosis in this latter case was "pernicious anemia in latent syphilis." The patient, a woman 45 years of age, showed bony calcifications in both femurs and died after hemorrhages from the nose, retina, and genitals. The pathologic-anatomical diagnosis was: "calcified gummata in both femurs; latent syphilis; anemia." The two remaining cases had been diagnosed as "calcified enchondroma" before the radiologic entity of bone infarction was known (prior to 1948).

In all cases of bone calcification located in the metaphyseal and epiphyseal regions, bony infarcts should be suspected.

Eleven roentgenograms.

ERNST A. SCHMIDT, M.D.
Denver, Colo.

Roentgen Findings in the Diagnosis and Management of Infantile Scurvy With a Report of Three Cases. Leonard S. Ellenbogen, Aldrich C. Crowe, and Martin Green. J. M. Soc. New Jersey **48:** 73–76, February 1951.

Though prevention of scurvy is such a simple thing, cases still appear from time to time in which for one reason or another vitamin C is not given or is destroyed by heat before ingestion. Clinical and roentgenographic signs are apparent after three months of the vitamin deficiency.

Nothing new is presented in this article but it is a good summary. Pathologically the lack of vitamin C results in capillary fragility and hemorrhage plus an arrest in new bone formation.

Clinically there are sore mouth from gum hemorrhages, pain, tenderness and irritability from subperiosteal hemorrhages, anemia, and often malnutrition.

The x-ray changes are generalized atrophy of bone associated with thickening of the epiphyseal plates and increased density around the ossification centers. There are lateral spurs at the ends of the diaphyses often with clefts and crevices in the angles between the epiphyseal plate and the cortex. The cortex is thinned and there is a zone of rarefaction between the thickened epiphyseal plate and the shaft. Fractures and separations of the epiphyseal plate and subperiosteal hemorrhages are frequent. These changes are best seen at the knees, wrists, and ankles. With healing, there are thickening of the cortex, increased prominence of the spongiosa, disappearance of the zone of rarefaction, and increase in width of the dense ring about the ossification centers. If subperiosteal hematomas are present, deposition of calcium begins after administration of vitamin C, resulting in organization and calcification of the hematoma. With growth, the thickened epiphyseal plate is buried in the shaft and appears as a dense white line. The cuff of calcified hematoma is gradually resorbed and the epiphyseal fractures and displacements heal without requiring orthopedic intervention.

Three cases are reported and 5 roentgenograms are included, but the reproductions are poor.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Infantile Cortical Hyperostoses. Paul C. Colonna and B. A. Richardson. Am. J. Surg. **81:** 246–253, February 1951.

Five cases of infantile cortical hyperostoses are reported. The x-ray findings were quite consistent, comprising definite periosteal proliferation, marked soft-tissue swelling, and later irregular new bone formation. In one case periostitis involving the right ulna and right humerus developed during the patient's stay in the hospital. In another patient the x-ray findings followed closely the clinical course, showing definite improvement as the symptoms decreased.

Sixteen roentgenograms.

X-Ray Findings in Extensive Angiomatous Changes in the Region of the Right Upper Half of the Body. G. Bonse. Fortschr. a. d. Geb. d. Röntgenstrahlen **74:** 91–94, January 1951. (In German)

A 17-year old girl clinically showed numerous soft-tissue tumors in the region of the right supraclavicular fossa and over the right hemithorax, right arm, and right back. Radiologically the right clavicle was hypoplastic, and multiple soft-tissue tumors were seen in the right chest. Numerous phleboliths could be visualized in these tumors. The right hand was hypoplastic, with marked thinning and slight expansion of the cortex. The right fifth finger, as well as the thumb, showed demineralization. The proximal portion of the right ulna was considerably deformed, with a trabeculated or honeycombed structure. The distal portions of the ulna showed thickening of the periosteum. Numerous phleboliths were seen in the soft tissues of the upper arm, elbow, and forearm. Clinically and radiologically the case may be classified as one of extensive venous racemose angioma with transition to genuine diffuse phlebectasia and osseous involvement.

Four roentgenograms. ERNST A. SCHMIDT, M.D.
Denver, Colo.

Roentgen Pattern of Dysostosis Multiplex (Pfaundler-Hurler Disease). Rüdiger Seyss. Fortschr. a. d. Geb. d. Röntgenstrahlen **73:** 749–753, December 1950. (In German)

The author reports one case of dysostosis multiplex and discusses its etiology. The disease is also known as gargoylism or lipochondrodystrophy. The first case was described by Hunter in England in 1916 and since then about 130 cases have been reported in the literature. It was thought that it was caused by imbalance in the storage of lipids, but according to American authors it probably represents an abnormal storage of

complex carbohydrate glycogen or glyco-protein, with widespread involvement of different tissues. (See Reilly and Lindsay: Am. J. Dis. Child. **75**: 595, 1948. Abst. in Radiology **52**: 455, 1949. These writers also describe the roentgen appearances in detail.)

The author's patient was a 6-year-old mentally retarded boy with hepatosplenomegaly and bone changes which are fully described. A list of the differential diagnoses which should be considered in this type of osteopathy is given.

Four roentgenograms; 1 photograph.

JULIAN O. SALIK, M.D.
Baltimore, Md.

Neoplastic Alterations in the Ribs. A Roentgen Diagnostic Contribution. Bruno Bertiglia. Ann. radiol. diag. **23**: 178–234, 1951. (In Italian)

The author proposes in this article to compile a complete study of rib pathology and also to revise and review the significant literature on this subject.

After describing briefly several points of technical importance, he delves into the classification of primary tumors of the ribs, following this with a discussion of various clinical cases with emphasis on the radiological characteristics of both primary and secondary tumors, as observed personally and as recorded in the literature. He also considers the clinical aspects of these conditions. He ends his report with a discussion of several pathological conditions which are not strictly tumor but which deserve differentiation due to their similar characteristics, particularly lymphogranuloma and eosinophilic granuloma.

His discussion of rib tumors includes a very clear description of radiographic characteristics and clinical aspects. He reviews the recent classification by Coley and by Schinz.

There is also a full statistical analysis of 250 cases of rib tumor, of which the most common are cysts and chondrosarcoma. Great emphasis is placed on biopsy and its importance in differential diagnosis. The discussion dwells mainly on chondroma, osteochondroma, hemangioma, lipoma, osteoclastoma, as benign primary tumors; chondrosarcoma, Ewing's sarcoma, angiosarcoma, reticuloma, as primary malignant tumors; and, finally, tumors metastatic from the kidney, prostate, testicle, uterus, thyroid, gastro-intestinal tract, lung, and melanoma, as well as metastases of undetermined primary origin.

Forty-nine roentgenograms; 1 photograph.

MICHAEL INDOVINA, M.D.
Chicago, Ill.

Atlanto-Axial Fracture-Dislocation. G. O. Tippett. J. Bone & Joint Surg. **33-B**: 108–109, February 1951.

The author reports a case of atlanto-axial fracture dislocation which resulted from severe hyperextension of the neck when the patient was thrown from his horse and landed heavily on the right side of his face. Roentgenograms revealed fractures of the anterior arch and right lateral mass of the atlas, a fracture through the base of the odontoid, and posterior displacement of the odontoid, atlas, and skull in relation to the axis. Symptoms of this injury are classical, including severe occipital neuralgia and hyperesthesia of the back of the scalp. Frequently there are dysphagia and alterations in speech and taste due to tearing of the constrictors of the pharynx. The injury is not accompanied by severe cord involvement or by death as frequently as is dislocation of the atlas on the axis without fracture of the odontoid.

One roentgenogram. RICHARD A. SILVER, M.D.
Indiana University

Dysplasia of the Vertebra (A Study of the Pathogenesis of Spondylolisthesis). J. E. W. Brocher. Fortschr. a. d. Geb. d. Röntgenstrahlen **73**: 719–726, December 1950. (In German)

Spondylolysis and spondylolisthesis of the lumbar region are encountered relatively frequently. About 4 to 5 per cent of the population will be found on examination to have spondylolysis, but only a small fraction has any subjective complaints. Some authors assume the change to be produced by trauma, and some ascribe its origin to stress fractures. Friberg, however, states that the 4 to 5 per cent incidence is already found at the age of about ten years and that this would indicate a developmental origin (Acta chir. Scandinav. (supp. 55) **82**: 1–140, 1939).

In cases of Stage I spondylolisthesis it was found that the anterior slipping of the vertebra is greater in extent than the gap in the corresponding pars interarticularis. The latter is elongated, and in addition one often notes the presence of under-developed articular processes, especially the lower process of L-5. Occasionally hypoplasia of the entire arch and a spina bifida are also present. These changes may occur unilaterally, bilaterally, or in different combinations, such as a defect in the isthmus on one side and an elongation of the pars interarticularis on the opposite side. The latest research indicates that ossification of the arches starts in the cartilage and not in separate ossification centers; this may explain the variety of changes encountered.

The author terms spondylolysis and spondylolisthesis "dysplasia," similar in origin, for example, to coxa vara congenita, and bases the congenital and hereditary theory of etiology on the research performed by Friberg, who stated that 15 persons in a family of 61 were found to have spondylolisthesis, only 3 of them having subjective complaints. In another family where both parents had spondylolisthesis, the condition was found in 7 of the 9 children. These hereditary changes, the author calls "abiotrophy," after Gowers, who used this term to encompass other hereditary diseases, such as Friedreich's ataxia.

Five roentgenograms. JULIAN O. SALIK, M.D.
Baltimore, Md.

Kümmell's Disease. Howard H. Steel. Am. J. Surg. **81**: 161–167, February 1951.

In 1891, before the advent of the x-ray examination, Kümmell described a clinical entity manifested by trivial trauma to the spine followed by a short, indefinite, asymptomatic period, culminating in symptomatic, progressive, angular kyphosis. He presented 4 cases. Numerous examples have been reported since that time, and the sequence of injury, latent period, and onset of symptoms has been fairly well established as the clinical picture of Kümmell's disease. This symptom-complex may occur at any age, though it is unusual in young people.

Kümmell's disease or post-traumatic spondylitis is best described as delayed post-traumatic collapse of the vertebra with the essential pathology consisting of multiple, minute injuries of the osseous and ligamentous structures of the spine causing small interruptions in

bony continuity and blood supply. In the author's opinion, the diagnosis is not justified without negative lateral roentgenograms taken shortly after the trauma, with later films showing positive evidence of collapse. The amount of disability following spinal injury should not dictate the need for x-ray examination; injury to the spine, no matter how trivial, calls for roentgen study, with re-examination if symptoms recur.

The differential diagnosis must include tuberculosis of the spine, herniated nucleus pulposus, lumbar back strain, ankylosing spondylitis, primary or metastatic neoplasm, syphilitic spondylitis, hypertrophic arthritis, and neurosis.

The prognosis is good but depends on early diagnosis and institution of proper orthopedic measures.

Treatment is directed toward stabilization of the affected vertebrae.

Three cases are reported.

Six roentgenograms.

Manubrio-Sternal Joint in Ankylosing Spondylitis. Douglas L. Savill. J. Bone & Joint Surg. **33-B:** 56–64, February 1951.

Study of the manubrio-sternal joint in ankylosing spondylitis was undertaken because of its accessibility to biopsy and histologic study. Of 61 cases studied roentgenographically, 72 per cent were found to show changes after correction was made for the number in which some fusion would be expected due to normal aging. These changes were: (1) early transient osteoporosis with loss of definition at the joint margins; (2) erosion of bone ends; (3) varying degrees of bony fusion. A table is presented to demonstrate the relation of these changes to the duration of the disease as well as to show the rather close similarity to changes occurring simultaneously in the sacroiliac joints.

Histologic study was done on biopsy material from the manubrio-sternal joints of 5 of the 61 patients. In those showing erosion roentgenographically, the main feature was replacement of fibrocartilage of the joint by adult collagenous fibrous tissue which extended into adjoining bone. Local osteoclastic activity was seen, but inflammatory reaction was strikingly absent. The erosion was limited by a narrow zone of sclerosis. In the one case studied histologically in which fusion was evident on the roentgenogram there was replacement of cartilage by bone, with collagenous fibrous tissue filling in the bony interstices.

Fourteen illustrations, including 10 roentgenograms; 2 tables.

D. E. VIVIAN, M.D.
Indiana University

Ossifying Chondromatosis of the Spine with Secondary Reticulosarcomatosis. G. Lehmann and F. Leicher. Fortschr. a. d. Geb. d. Röntgenstrahlen **74:** 94–101, January 1951. (In German)

The authors report a case of chondromatosis of the spine and secondary reticulosarcomatosis, with postmortem observations. Six years prior to the patient's death, when he was 53 years of age, an x-ray diagnosis of chondromatosis of the third lumbar vertebra had been made; osteitis deformans, tumor metastasis and plasmocytoma were excluded. Four years later, four series of deep x-ray therapy with doses of 150 r were given to the involved area, on account of increased pain. In 1949, the year of death, roentgen examination showed dense sclerosis of the second and third lumbar vertebrae with flattening and synostosis. No normal bone structure could be demonstrated in this area. Laminectomy was performed and the histologic diagnosis pointed to chondromatosis ossificans without evidence of malignancy. About six weeks later the patient died, showing cachexia, nitrogen retention to 72 mg. per cent, diminished diuresis, and extensive edema over the lower extremities. Autopsy revealed chondromatosis ossificans of the second and third lumbar vertebrae with flattening, broad synostosis, extensive eburnization, and sarcomatous degeneration across the remaining parenchyma. Chondromatous foci were also seen in the 12th thoracic vertebra, and there were cartilaginous foci in the sternum. Extensive retroperitoneal reticulosarcomatosis was present, with infiltration of the adjoining first, fourth, and fifth lumbar vertebrae, the psoas muscles, wall of the aorta, left kidney and both ureters, combined with stenosis and tumor invasion of the left renal pelvis, the left renal vein, and the inferior vena cava. There were also metastases in the diaphysis of the right femur, the third, fifth and seventh right ribs (with tumor thrombosis of the costal veins), the liver, the gastrocolic ligament, and left upper lobe of the lung (combined with tumor thrombosis of two branches of the pulmonary artery in the left upper lobe). The edema was due to thrombosis of the pelvic veins and the prostatic plexus.

The authors conclude that the primary cartilaginous lesion was represented by multiple enchondrosis with foci in the sternum, the twelfth thoracic vertebra, and the second and third lumbar vertebra, and that calcification of the foci and eburnization of the remaining bone tissue were due to the static permanent strain in combination with microscopic trauma and reactive callus proliferation. They assume that the fatal reticulosarcomatosis must be considered an independent primary tumor originating in rests of the endosteum or medullary reticulum. Static-mechanical chronic irritation as well as irradiation seemed to have been etiologic factors.

One roentgenogram; 1 photograph; 1 photomicrograph.

ERNST A. SCHMIDT, M.D.
Denver, Colo.

Angular Dorsolumbar Kyphosis as an Unrecognized Skeletal Sign of Congenital Myxedema. W. Swoboda. Fortschr. a. d. Geb. d. Röntgenstrahlen **73:** 740–749, December 1950. (In German)

The author reports 7 cases of infantile myxedema in which gibbus was found. It was due to incomplete wedging of the second lumbar vertebra or one or two adjacent vertebrae which were affected to a varying degree. The involved vertebra or vertebrae were shown in a lateral view to have a step-like defect in the anterior superior aspect, giving a wedge-shaped appearance, and this roentgen pattern was very characteristic. In some instances the findings were easily recognizable clinically, but in others only a thorough inspection showed the deformity. In none of the cases was any long follow-up available, but since the paper was originally written, 3 additional cases had been seen.

In the differential diagnosis, gargoylism (dysostosis multiplex or Hurler's syndrome), Morquio's disease (chondro-osteodystrophy), and achondroplasia (chondrodystrophy) should be considered. Although the histopathology in these diseases may differ, the x-ray findings and the end-result are the same. The author discusses the underlying changes in the cartilage producing this disturbance in growth and offers his opinion

that they represent a developmental anomaly of the fetus *in utero*.

Six roentgenograms; 1 drawing.

JULIAN O. SALIK, M.D.
Baltimore, Md.

Protrusions of the Lumbar Intervertebral Discs. A Clinical Review Based on Five Hundred Cases Treated by Excision of the Protrusion. John E. A. O'Connell. J. Bone & Joint Surg. **33-B:** 8–30, February 1951.

A complete review of the clinical data personally obtained by the author from 500 patients with lumbar disk protrusion operated upon between 1938 and 1948 at St. Bartholomew's Hospital, London, is presented. In 85 per cent the patient had sustained injury in lifting a heavy weight or in falling. The pain was predominantly unilateral, involving the lumbar spine and/or lower limb when the patient presented himself for surgery. Only occasionally was it bilateral or alternating in distribution.

Good radiographic examination of the lumbar spine is necessary to reveal other lesions which might be responsible for the symptoms, such as neoplasms, congenital variations, or tuberculous spondylitis. A protrusion is suspected on demonstration of a narrowed intervertebral space with sclerosis of the adjacent vertebral surfaces and perhaps lipping of their margins. Findings indicative of the presence and level of protrusion were positive in 57 per cent of the author's series, doubtful in 18 per cent, and negative in 25 per cent. The author believes that myelography should be used only in atypical cases and when a neoplasm is suspected. A clinical diagnosis of lumbar disk is considered more accurate than a myelographic one.

The technic of operation is explained and diagramed. In the series reported, 92 per cent of the patients were completely free from symptoms or greatly improved.

Twenty-three illustrations; 14 tables.

D. C. GASTINEAU, M.D.
Indiana University

Less Common X-Ray Findings in the Sacroiliac Joints with Lumbago in Women. August Verhagen. Fortschr. a. d. Geb. d. Röntgenstrahlen **74:** 212–218, February 1951. (In German)

Lumbar pain is a frequent complaint in general and gynecological practice. It is found more frequently in women, due to the stress and pressure incident to pregnancy and delivery. These conditions predispose toward secondary changes, the most common of which is arthritis deformans. X-rays studies are essential for diagnosis, but must be considered in conjunction with the clinical and physical findings.

In the author's series of 108 cases, 55 showed no recognizable x-ray changes, 21 showed arthritis deformans in one or both sacroiliac joints, 18 showed other pathological changes in the lumbar spine and pelvis, and in 10 cases there was some form of congenital deformity or anomaly.

To illustrate the less common findings, the author reports a case of tuberculous arthritis and a case of osteitis condensans of the sacroiliac joint. Diagnosis of the latter condition rests upon the sharp demarcation of the process and the absence of any disturbance in the joint itself.

Four roentgenograms. E. W. SPACKMAN, M.D.
Fort Worth, Texas

Osteochondromatosis of the Hip Joint. Ross Bloom and J. N. Pattinson. J. Bone & Joint Surg. **33-B:** 80–84, February 1951.

Osteochondromatosis of the hip joint is rare. Among 105 cases of osteochondromatosis reported from the Mayo Clinic between 1910 and 1945 (Mussey and Henderson: J. Bone & Joint Surg. **31-A:** 619, 1949), there were only 5 involving the hip. The authors add 3 cases and stress the radiographic features and the value of arthrography in demonstrating non-opaque loose bodies in the joint space.

Pressure erosions occur at the cervico-capital junction, and the neck of the femur has a conical appearance. Occasionally there is an associated erosion involving the acetabulum. After operative removal of the loose bodies the contour of the neck is partially restored.

Arthrography is of definite aid when the loose bodies are few in number or are relatively radiolucent.

Seven roentgenograms; 2 photographs.

JOHN S. SCOTT, M.D.
Indiana University

Osteochondromatosis of the Hip Joint. Report of a Case. Gawad Hamada. J. Bone & Joint Surg. **33-B:** 85–86, February 1951.

A 20-year-old railroad worker sustained a moderately severe blow to the right buttock eight months before hospital admission for pain and limitation of motion of the right hip. A film demonstrated a single rounded opaque body just above the neck of the right femur. The patient was placed in plaster for four months and a subsequent film showed the loose body to better advantage against the disuse osteoporosis. A third film, three months later, revealed the presence of many loose bodies which had partially calcified at this time. After operative removal of these the patient had remained well for three years.

The author states that the apparent rapid appearance of these bodies aroused suspicion of a malignant process, but the clinical course and biopsy (chondroma) refuted this.

Four roentgenograms; 1 photograph.

JOHN S. SCOTT, M.D.
Indiana University

Diaphysial Aclasis: Report of an Unusual Case. V. H. Ellis and J. G. Taylor. J. Bone & Joint Surg. **33-B:** 100–105, February 1951.

A case of diaphyseal aclasis is presented which showed several interesting features: one of the exostoses suddenly began to grow years after normal bone growth had stopped; there were congenital block vertebrae in the cervical spine; the appearance of some of the bones suggested dyschondroplasia.

The patient was a 40-year-old man who sought medical advice because one of many long-standing hard swellings on his body had recently grown to large size. Studies revealed diaphyseal aclasis with what was believed to be malignant change in an exostosis of the femur. Hip disarticulation was attempted but the patient did not survive. Although it was not possible histologically to prove or disprove the clinical suspicion, the lesion was considered to be a chondrosarcoma of low-grade malignancy.

According to the authors, the incidence of malignant transformation in diaphyseal aclasis is probably low, but rapid increase in size of a pre-existing exostosis,

with pain, must generally be regarded with suspicion.

The roentgenograms in this case showed more calcified cartilage than is usually seen in diaphyseal aclasis, and dyschondroplasia was considered. The differential diagnosis is discussed. Abnormality of the cervical spine is not a usual feature of diaphyseal aclasis.

Five roentgenograms; 3 photographs.

RICHARD A. SILVER, M.D.
Indiana University

Congenital Posterior Bowing of the Tibia with Talipes Calcaneo-valgus. B. F. Miller. J. Bone & Joint Surg. **33-B:** 50–55, February 1951.

The author distinguishes three types of congenital bowing of the tibia and thus supports posterior bowing as a clinical entity. The three types are:

1. Anterior bowing with talipes equinus and frequently other anomalies.
2. Anterior bowing without foot deformity or other anomaly, which is almost invariably the precursor of pseudarthrosis.
3. Posterior bowing with talipes calcaneo-valgus.

Therapy consists of manipulative molding and splinting. There is often a resulting minimal shortening of the extremity.

Five case reports are presented with 16 roentgenograms.

W. J. LITTLE, M.D.
Indiana University

Application of the Technic of Radiologic Enlargement to the Study of Chronic Articular Affections. G. J. van der Plaats and J. Fontaine. J. belge de radiol. **34:** 203–219, 1951. (In French)

In the radiologic study of chronic joint diseases good technical procedures are highly desirable. This is important not only in diagnosing the very early changes or minute lesions, but also in following the slow evolutionary course of the different disease processes. Some method of radiologic enlargement would seem to be highly desirable. It has long been known that an object being radiographed will appear larger on the roentgenogram if the distance between the object and the film is increased. However, in the past this has led to a lack of detail in the film because of scatter. With the use of a very small focal spot, namely 0.3 mm. in diameter, the rays assume what is essentially a more parallel course, thus leading to better definition.

Very early cases of osteochondritis dissecans such as occur about the knee and the second metatarsal may be more clearly visualized by this method. Numerous reproductions are shown to illustrate the various portions of the skeleton exhibiting articular pathologic changes.

CHARLES M. NICE, M.D.
University of Minnesota

Anemia of Cancer Patients and Its Relation to Metastases to the Bone Marrow. Shu Chu Shen and F. Homburger. J. Lab. & Clin. Med. **37:** 182–198, February 1951.

It is usually considered that anemia in cancer patients, excluding that obviously due to blood loss or, in rare instances, to hemolysis, is due to bone marrow invasion. This mechanical explanation does not, however, gain the credence of certain competent authorities, who point out that the unaffected areas of the marrow do not take over the compensatory activity which might be expected on the basis of this theory. Furthermore, cancer patients with anemia have frequently been encountered in whom no underlying pathologic condition of the skeleton was present, and conversely, patients with extensive metastases to the bone marrow but with no anemia.

These considerations led the authors to make the following studies. (1) The relation of the incidence and severity of anemia to bone marrow metastases was studied by analysis of the morphologic data concerning the peripheral blood and by correlation of these data with bone marrow involvement in 193 patients with advanced carcinoma. (2) A hematopoietic agent, cobaltous chloride, was given orally to selected patients, with and without metastases to bone, to ascertain whether the bone marrow of these patients was capable of increasing red cell production.

Of the 193 patients with advanced cancer studied, 116 were considered to be anemic because the hemoglobin level was 80 per cent or below; in 52 of this group the hemoglobin was between 70 and 80 per cent; in 42 between 55 and 69 per cent, and in 22 between 38 and 54 per cent. Classified according to pathogenesis, 28.5 per cent of the anemias were due to blood loss alone, 2.6 per cent to hemolysis, 56 per cent were of the myelopathic type, and 12.9 per cent of the myelopathic type complicated by blood loss. Fifty of the 193 cancer patients had evidence of osseous metastases. Of the patients with metastases, 24 were anemic. The remaining 26 were not anemic.

Cobaltous chloride was given to 16 anemic patients (8 with and 8 without metastases to bone), 60 to 240 mg. daily. The 6 patients with osseous metastases who received an adequate trial of the drug showed a reticulocytic response. Two of these patients died before a rise in hemoglobin might have been expected. One patient failed to show any rise in hemoglobin, although the cobalt was continued for twenty-four days. In the other 3 patients in this group, the reticulocytosis was followed by elevations to normal of the red cell counts, hemoglobin, and hematocrit levels. Of the 4 patients without osseous metastases who could tolerate cobalt for an adequate period, 3 showed definite reticulocyte responses followed by increase in red cells, hemoglobin, and hematocrit reading. The other patient showed no reticulocyte or other hematologic response to iron, liver, or cobalt therapy.

These results indicate that the presence of metastases in bone usually has no relation to the development of anemia in cancer patients, and that cobalt therapy in cancer patients with anemia may increase erythropoiesis regardless of skeletal metastases. Cobalt therapy fails to produce subjective improvement and often causes symptoms referable to the gastro-intestinal tract and in some instances suggestive of angina pectoris. It is also concluded that anemia associated with cancer is not usually due to bone marrow replacement by neoplastic tissue.

Two roentgenograms; 5 charts.

GYNECOLOGY AND OBSTETRICS

Progress in Gynecologic Roentgen Diagnosis with Special Consideration of Sterility. H. Goecke. Fortschr. a. d. Geb. d. Röntgenstrahlen **74:** 66–76, January 1951. (In German)

The author reports his experience in some 1,500 uterosalpingographies. As a contrast medium he prefers iodized oil to a water-soluble preparation. Mano-

metric control he considers unnecessary in the majority of cases. Fluoroscopy was not used in view of the possible radiation damage to the patient. Bed rest during the twenty-four hours following the procedure is recommended; as a rule the patients were hospitalized for two or three days.

Certain dangers of salpingography cannot be denied, especially oil embolism, uterovenous reflux, and even death, although the number of reported fatalities is small (0.018 per cent up to 1944). A follow-up roentgenogram twenty-four hours after salpingography is considered indispensable. In addition to the information regarding patency of the fallopian tubes, valuable data may be obtained concerning size and configuration of the uterine cavity, abnormalities, hypoplasia, etc.

The opinion that sterility may be diagnosed definitely if the tubes are closed to the passage of opaque medium is not shared by the author. Other factors (age of patient, duration of married life, previous inflammations in the genital area, laparotomies, etc.) must be considered in addition to the salpingographic findings in order to reach valid conclusions regarding sterility in the female.

Seventeen roentgenograms; 2 photographs.

ERNST A. SCHMIDT, M.D.
Denver, Colo.

Advantages and Disadvantages of Salpingography with Particular Reference to the Use of Diodone Viscous. J. H. E. Bergin. Brit. J. Radiol. **24**: 93–102, February 1951.

This paper is based on a review of 270 consecutive cases in which salpingography was done in one clinic over a four-year period. In 201 instances lipiodol was used, and in 69 a viscous preparation of diodone, known by the trade name "viskiosol" (diethanolamine salt of diiodo-pyridine with 6 per cent polyvinyl alcohol).

The dangers attendant on the use of lipiodol are discussed, but only two are regarded as significant: the spreading of infection and tubal occlusion through inspissation.

The technic of examination is described, and the general principles are outlined. The author recommends making the examination under screen control. When filling is complete, anteroposterior films are made; the instruments are then removed and lateral and postero-anterior views are obtained.

Block at the isthmus was frequent with lipiodol, due to spasm; with viskiosol this occurred less often.

As viskiosol is less viscous than lipiodol and is water-soluble, it produces somewhat different appearances. Globule formation does not occur. The edges of the opaque shadow are not quite so sharp. These differences are particularly apparent when the medium reaches the peritoneum. It is wiser, therefore, to use larger amounts of viskiosol.

Twelve roentgenograms.

SYDNEY J. HAWLEY, M.D.
Seattle, Wash.

THE GENITO-URINARY SYSTEM

Roentgen Demonstration of Adrenals and Kidneys by Perirenal Air Insufflation. F. Kokas and Z. Zsebök. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 218–225, February 1951. (In German)

The inner structure of the kidney, including pelvis, infundibula, and calyces, is well shown by pyelography, but in many cases it is important to determine the form, size, and position of the kidney and the character of the perirenal area. This is best accomplished by air insufflation. The authors have modified and simplified this procedure as follows:

The patient is placed on the operating table in a position similar to that used in kidney surgery. The hip is supported and elevated, and the patient bent somewhat forward, so that the 12th rib and the crest of the ilium are separated as far as possible and the other abdominal organs allowed to drop away from the kidney area. The point of injection is selected 1.5 to 2.0 cm. below the apex of the angle formed by the 12th rib and quadratus lumborum muscle, exactly at the edge of the muscle. Novocaine injection is carried to a depth of 4 to 5 cm. A medium bore needle with a rubber tube attached is now inserted and slanted forward toward the vertebral body to an angle of approximately 45 degrees until the retrorenal fascia has been pierced. The subperitoneal fascia splits into two layers to surround the kidney and form a stabilizing apparatus for it. The compartment is closed laterally and cranially and opens medially and caudally. Within it lies the perirenal fat. As the needle enters this fat layer, there is a sudden slight release of resistance. If the needle penetrates too deeply, it damages the kidney capsule, causing pain, and must be withdrawn 1 to 2 mm. As the needle is slowly inserted, an occasional attempt is made to inject air; lack of resistance to air injection indicates that the perirenal fat layer has been entered. If the needle has entered the muscle layer, there is definite resistance to air injection, and forcing causes a palpable emphysema. Proper depth is difficult to estimate, especially in obese patients. It is well to attempt aspiration after each forward thrust as a precaution against entering a vessel. The feeling of pressure is regarded as a better guide than a manometer.

From 200 to 300 c.c. of air, never more than 500 c.c., are injected. Others have used up to 800 c.c., but the lesser amount protects against severe blood pressure reduction through sympathetic nerve reflexes. Eight to ten minutes are required for the injection, after which the needle is removed and the puncture site touched with iodine. The patient notices discomfort or moderate pain, first in the back and then in the abdomen, finally radiating to the thorax. Air infiltrates at first downward in the fascial space along the psoas muscle, then gradually spreads in all directions. By lightly massaging the abdominal wall, even distribution can be attained and the distress in the loin gradually diminishes or disappears. The patient then stands and swings the arms in slow wide circles and bends downward several times. X-ray pictures are made thirty minutes after the injection, which allows time for even distribution of the air. This is of particular importance on the right side, to demonstrate the adrenal.

Very seldom are both sides examined at the same sitting; an interval of one or two days is advisable, as bilateral injection causes respiratory embarrassment due to upward pressure on the diaphragm. However, if it is essential to inject both sides at one sitting, no more than 200 c.c., or at most 300 c.c., may be used. The patient is advised to rest one day in bed following the procedure.

Tomography has been found extremely useful, especially in heavy patients. The levels selected are 6.0, 7.0, and 8.5 cm. from the table top, the patient lying supine with knees raised and spine flattened

against the table and the tube moving in the long axis of the body.

Contraindications to the procedure are inflammation and infectious conditions of the kidney and hydronephrosis. The authors regard the possibility of air embolism or other untoward effects as extremely remote providing careful technic is followed. They believe that air has the advantage over oxygen or carbon dioxide of being absorbed more slowly and allowing more time for careful examination.

Nine roentgenograms; 1 photograph; 1 drawing.

E. W. SPACKMAN, M.D.
Fort Worth, Texas

Cysts of the Kidney. Harold C. Ochsner. Am. J. Roentgenol. **65**: 185–199, February 1951.

The author reviews the cases of renal cyst seen in Methodist Hospital in Indianapolis, 1944 to 1948 inclusive, during which period 107,656 in-patients were admitted to the hospital and 8,948 cystoscopies were performed.

First the problem of the simple cyst and its diagnosis is presented. The pyelographic abnormalities associated with this diagnosis include changes in contour and size of the calyces and renal pelvis and disturbances in the position and outline of the ureter. The most typical calyceal deformity is said by Braasch and Hendrick (J. Urol. **51**: 1, 1944) to be a crescentic outline of the border of the adjacent calyx. Other calyceal abnormalities mentioned by these authorities are: elongation, dilatation, displacement, flattening, abbreviation, and obliteration. The deformities of the kidney pelvis include dilatation, displacement, flattening of the border adjacent to the cyst, and general deformity. Usually the deformity produced by other types of neoplasms appears to be more extensive than that produced by cysts. The associated clinical and surgical findings are correlated in the proved cases in this series.

Calycine cysts constitute a special sub-group of simple cysts. They take the form of small cortical cavities communicating with a minor calyx and are situated just distal thereto.

Hemorrhagic cysts of the kidney are less frequent than simple serous cysts and may arise spontaneously or as a result of vascular abnormality, trauma, or renal cancer. These cysts are usually large and solitary, and continuous with the contour of the kidney surface, not projecting like serous cysts. The usual urographic findings are abbreviation of adjacent calyces and compression and flattening of the adjacent portion of the renal pelvis. Frequently the position of the kidney and its axis will change as the result of the weight of the cyst. The clinical findings in 2 cases are correlated with the radiographic observations.

Multilocular cysts are similar to simple or solitary cysts in that they are unilateral, involve similar locations in the kidney, and have identical wall structure. Their radiographic differentiation from hypernephroma, however, is frequently difficult.

Although there are some unilateral cases of polycystic disease of the kidney, the vast majority are bilateral, and there are frequently associated cysts in the liver, pancreas, spleen, ovary, and lung. Polycystic disease of the kidneys may be discovered at two age periods in particular: in the newborn, who die as a result, and in people well past middle age, who usually show some signs of renal insufficiency and hypertension. The urographic manifestations usually consist in a bizarre sprawling of the calyces and deformity of the pelves of greatly enlarged kidneys. The minor calyces lose their normal cup-shape and become flattened and distorted by pressure from adjacent cysts. Arc-shaped depressions occur in many calyces.

In the period studied by the author the incidence of simple serous cysts in 897 postmortem examinations was 1.67 per cent. In the same period, necropsy revealed 2 cases of polycystic disease of the kidneys, 1 hemorrhagic cyst associated with several retention cysts and large serous cysts of the opposite kidney, and 2 cases of unilateral multilocular cysts.

The author summarizes by giving a simple classification of renal cysts which include all of the above, grouped under the following headings: (I) congenital cysts, including polycystic disease of the kidneys; (II) acquired cysts which include simple serous, hemorrhagic, multilocular, and retention cysts, as well as those secondary to other renal pathological changes such as infection and neoplasia.

Twenty-four roentgenograms. I. MESCHAN, M.D.
University of Arkansas

Nephrocalcinosis. William J. Engel. J. A. M. A. **145**: 288–294, 1951.

The author discusses the clinical history and findings in 7 cases of bilateral nephrocalcinosis, 5 of which were in adults and 2 in children. The youngest patient was four months of age and the oldest sixty years, indicating that the disease is not restricted to any age group. All the patients showed characteristic roentgen findings of clusters of calcific deposits in the renal pyramids. Primary calculi were present in 5 of the 7 cases.

Evidence is presented which is in keeping with Albright's conception that this type of nephrocalcinosis is of renal origin and is the result of damage to the distal convoluted tubules, which is followed by calcification in the renal pyramids. There is a disturbed renal function usually associated with hyperchloremia and acidosis in the presence of adequate glomerular function, a point of differential diagnosis from renal rickets. Dysfunction of the distal tubules is indicated by inability to concentrate the urine, resulting in polyuria; also by the failure of the kidney to secrete an acid urine and by systemic acidosis. The diffuse calcification noted on the roentgenogram is the result of, or follows, the renal tubular damage.

The author points out that in many instances (6 of the 7 cases presented) the tubular damage may be due to direct toxic action of sulfonamides.

Treatment is designed to relieve the acidosis, reduce the hyperchloremia, and correct the negative calcium balance. These objectives are attained by administering a "citrate mixture" which supplies added base and creates an intestinal acidosis and a blood alkalosis. At the same time sodium chloride in the diet is restricted and vitamin D in normal doses is administered.

Six roentgenograms. ROBERT H. LEAMING, M.D.
Memorial Center, N. Y. C.

Retrocaval Ureter. C. Robert Schmidt, D. W. Huebert, and James M. Beazell. Arch. Surg. **62**: 299–302, February 1951.

A single case of retrocaval ureter is presented. Two roentgenograms show the abnormal position of the ureter and the appearance following transplantation.

In their brief review of the literature, reference is

made to McElhinney and Dorsey (J. Urol. **59:** 497, 1948. Abst. in Radiology **52:** 299, 1949), who collected 36 reported cases and added one of their own. Only 3 of the number were diagnosed preoperatively, all since 1940. In a footnote, the authors mention another example reported after their paper was accepted for publication. [This anomaly is being reported with increasing frequency. Abstracts of nine reports appeared in RADIOLOGY in 1950 and 1951.—ED.]

S. F. THOMAS, M.D.
Palo Alto, Calif.

Limitations of Roentgen Rays in Diagnosis of Bladder Stone. Fay H. Squire and Herman L. Kretschmer. J. A. M. A. **145:** 81–82, Jan. 13, 1951.

This is an analysis of 257 cases of proved bladder calculi. A positive diagnosis of bladder stone was made from the plain film in 87.9 per cent of the series. A critical review of the films revealed 6 more cases that were overlooked in the original reading. In the remaining 12 per cent the stones could not be demonstrated. There were 8 cases of pure uric acid stones; 5 could not be visualized roentgenographically, but 3 cast a positive shadow.

The authors state that in their experience roentgenograms have revealed bladder stones in a higher percentage of cases than is usually reported.

PAUL W. ROMAN, M.D.
Baltimore, Md.

BLOOD VESSELS; LYMPHATICS

Broadening of the Innominate Artery (Truncus Brachiocephalicus). Hans-Georg Meyer-Krahmer. Fortschr. a. d. Geb. d. Röntgenstrahlen **74:** 193–196, February 1951. (In German)

In aneurysmal enlargement of the innominate artery there is a broadening of the vascular shadows to the right and above the level of the aortic arch, usually associated with pulsation and murmur in the right supraclavicular region. The condition is frequently due to syphilis associated with hypertension or to hypertension with sclerotic changes, in which case there may be similar changes in the aorta.

The x-ray diagnosis is based on the general broadening of the vascular shadows above and to the right of the arch of the aorta, with a rounded area within the venous shadow of greater density than that usually representing the superior vena cava. This appearance is caused by superimposition of the shadows of the dilated innominate artery and the superior vena cava. Oblique views are important as confirmatory evidence. In many cases, the trachea and esophagus are displaced and there may be erosion of the clavicle or sternum. Actual malacia of the trachea is sometimes observed. In differential diagnosis, aortic aneurysm, tumor, and inflammatory masses are to be ruled out.

Some authors believe that the broadening and increased density caused by the dilated innominate artery are invariably associated with sclerotic changes. There may, however, be no observable pulsation if an extreme degree of sclerosis (often associated with dense calcification) or a blood clot is present. Associated mild cardiac changes may be shown by the electrocardiographic examination.

Eight roentgenograms. E. W. SPACKMAN, M.D.
Fort Worth, Texas

Reflux of the Intestinal Chyle in the Lymphatics of the Leg. Servelle and Deysson. Ann. Surg. **133:** 234–239, February 1951.

Fifty cases of elephantiasis of the lower extremity were studied by venography and lymphography. In 5 of these, examination of the lymph showed a high lipid content, resulting in a distinctly lacteal appearance as compared with the usual crystal clear fluid and indicating a reflux of intestinal chyle into the lymphatics. The lymphograms in these 5 cases were altogether typical of elephantiasis. Incompetence of the valvular mechanisms was demonstrated in all; the lymph channels were markedly dilated. In 1 case there was a congenital malformation of the femoral vein at the proximal end of Hunter's canal. None of the cases, however, reveals a plausible mechanism for the presence of the lacteal fluid in the lower extremity.

In treating elephantiasis the authors use their own technic of superficial total lymphangiectomy. They stress resection of the node of Cloquet, the most superior of the subinguinal nodes, and closure of the crural canal to prevent lymph reflux into the genitalia.

Four roentgenograms. JOHN F. RIESSER, M.D.
The Henry Ford Hospital

TECHNIC; CONTRAST MEDIA

Some Results of the Laminagraphic Study of Retropneumoperitoneum. Bruno Bonomini. Radiol. med. (Milan) **37:** 105–113, February 1951. (In Italian)

Retropneumoperitoneum, described by Ruiz Rivas in 1948 (Arch. españ. urol. **4:** 228, 1948), consists of the injection of gas in the retroperitoneal areolar tissue through a needle inserted just posterior to the anus. The gas usually infiltrates the whole retroperitoneal space and sometimes extends into the mesentery. The complex images obtained in plain films may be clarified by the use of laminagraphy, and the author presents numerous laminagraphs outlining clearly the various retroperitoneal organs and structures. Of much interest is the direct visualization of the body and the tail of the pancreas. If this could be consistently expected, it would represent a substantial advance in abdominal diagnosis.

Nine roentgenograms. CESARE GIANTURCO, M.D.
Urbana, Ill.

A Position of Value in Studying the Pelvis and Its Contents. Gerard Raap. South. M. J. **44:** 95–98, February 1951.

The Chassard-Lapiné position was first described by those authors in 1923. The patient is seated on the radiographic table in a sharply flexed posture and the central ray is directed through the lumbar or sacral area depending on whether emphasis of the anterior or posterior half of the pelvis is desired. The contralateral half of the pelvis can be studied by deflecting the spine to either side. Satisfactory films have also been obtained by seating the patient on a small bench with a Lysholm grid and cassette under the buttocks.

Radiographic factors are practically the same as those which apply in lateral projections of the pelvis. In the average patient 100 ma., 40 inches distance, 80 kv., 5 seconds suffices.

This position serves to delineate changes in accessory articulations of the sacroiliac areas. It affords a tangential view of the inner pelvic rim, depicts the acetabula in a plane at right angles to the anteroposterior,

and does the same for the circumference of the femoral head and neck. It also permits an easy projection of both sides of the pelvis for comparison as to symmetry, and in children affords a comparison of the epiphyses at the femoral head. It is of use in demonstrating the ureters and their relation to the bladder, and in hysterosalpingography with reference to the size and shape of the uterine cavity and location of the ovaries.

This author's interest is chiefly concerned with the examination of the colon, especially the few centimeters just beyond the reach of the sigmoidoscope. He feels that a projection at right angles to the usual angles is of value because of the folding and overlapping of coils of bowel in a horizontal plane. He includes at least one study in this position in all examinations of the colon.

Five roentgenograms; 1 photograph.

MASON WHITMORE, M.D.
Jefferson Medical College

Delayed Death Following Intravenous Administration of Diodrast. Gasper A. Gulotta and Harry Leavenbrook. New York State J. Med. **51:** 396, Feb. 1, 1951.

An unusual fatality due to diodrast is recorded, occurring twenty-eight hours after intravenous injection of the medium. No pre-existing kidney damage or other contributory factors could be found postmortem. Convulsions and unconsciousness followed the injection within minutes, with a downhill course including development of pulmonary edema and papilledema.

Apparently no allergy history was taken nor were sensitivity tests performed. [Granted these will not prevent every fatality, some at least will be avoided. Medicolegally, also, one is on safer ground if the allergy history is taken and at least one sensitivity test done.—Z. F. E.]

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

RADIOTHERAPY

Roentgen Treatment of Cancer of the Oesophagus. Rolf Köhler. Acta radiol. **35:** 207–220, February-March 1951.

The author presents the results of the treatment of 296 cases of carcinoma of the esophagus seen at the Central Institute of Radiotherapy in Helsinki, Finland. The patients in general were treated with the maximum dosage tolerated. Multiple oblique portals were utilized with 190-kv. radiation and 1 mm. Cu filter. A tumor dose of 5,000 r given at the rate of 150 r (tumor) per day was planned but was attainable in only 45 per cent of the cases.

The mortality was 22 per cent in the first three months, 50 per cent in six months, and 81 per cent in one year. Only 3 per cent of the patients were living two years after treatment was begun. The end-results compare favorably with previously reported series utilizing rotation therapy and it is concluded that crossfire therapy is of equal value.

Though the curative rate is very small, over half of the patients benefited by the treatment. The palliative result was highly dependent on the patient's ability to tolerate heavy roentgen therapy and little effect was obtained with tumor doses below 3,000 r. The treatment was considered to have a certain life-prolonging effect but not for more than four to six months on the average.

Two cases with survivals of five years are reported in some detail.

Two roentgenograms; 2 graphs; 3 tables.

DONALD F. MAURITSON, M.D.
Cleveland City Hospital

Management of Carcinoma of the Cervical Esophagus. Danely P. Slaughter and Erwin H. Roeser. S. Clin. North America **31:** 85–96, February 1951.

Carcinoma of the cervical esophagus presents a somewhat different problem than carcinoma of the thoracic portion. The attachment is less rigid, allowing a lesion to become larger before producing symptoms. On the favorable side is the fact that wider resection can be accomplished than in the mediastinum. The larynx and thyroid can be sacrificed if necessary for complete removal. The diagnosis is made by x-ray examination and confirmed by biopsy. The authors cite the results of irradiation therapy in the hands of others. Though some relatively long-term survivals are reported and it is stated that amelioration of symptoms of esophageal obstruction may be obtained in 75 per cent of cases, the authors still characterize radiotherapy as "a most unhappy chapter." External therapy, they state, is limited by inability to deliver a uniform tumoricidal dose in most cases and intraluminal radium therapy has not only failed to cure but has been complicated in some instances by fatal perforation.

Going on to "happier" fields (though they cite no reasons or statistics to back up their feelings) they list four methods of surgical attack:

1. Local resection and primary anastomosis (feasible only in very early cancers of low-grade malignancy).
2. Surgical construction of an artificial esophagus by mobilizing parts of the alimentary tract. Many attempts have been made at tunneling stomach, jejunum, and even colon subcutaneously to meet the proximal end of a resected esophagus but the procedure is rarely used. Complications are the rule—narrowing of the stoma, ulceration, fistula formation, and intestinal necrosis from lack of sufficient blood supply or thrombosis.
3. Local resection with primary repair, using a cervical skin flap. This is a practical procedure for tumors high in the esophagus. It cannot be employed when the site is low in the neck, near the thoracic inlet, since adequate resection would require excision of the upper mediastinal esophagus.
4. Cervical gastro-esophagostomy. This is probably the most commonly used procedure, being essentially the same as for resection of the lower esophagus except that the stomach is more fully mobilized to bring it up so far.

One roentgenogram; 5 drawings.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Carcinoma of the Uterine Cervix: The Need for Combined Radiation and Surgical Treatment. A. P. Barry. Irish J. M. Sc., pp. 15–20, January 1951.

The author believes that the result of management of carcinoma of the uterine cervix by radiation therapy

alone leaves much to be desired. Three cases are presented in which radiation therapy was followed by the Wertheim-Bonney hysterectomy or pelvic exenteration. In the first case, the pathologic report after operation indicated a carcinomatous remnant in the cervix, which may or may not have been capable of reproduction. No nodes were reported. In the second case, tumor cells were not found in the cervix but were found in a lymph node. In the third case (Stage IV), the patient survived the exenteration and returned home. No follow-up is presented.

PAUL W. ROMAN, M.D.
Baltimore, Md.

Carcinoma of the Cervix in Pregnancy. R. R. Maier and M. Klein. Ohio State M. J. **47:** 139–142, February 1951.

The combination of carcinoma of the cervix and pregnancy is rare. It was seen 4 times in approximately 24,000 cases at the Mt. Sinai Hospital in Cleveland. The small number of cases nullifies any generalizations about the correct method of therapy. However, the authors have obtained some interesting impressions.

Therapy is roughly resolved into 3 phases, which are dependent upon the duration of gestation. In the first trimester, x-ray therapy should be started immediately. This will usually be followed by spontaneous abortion in about the third week of therapy, and this may be followed by radium therapy. In the second trimester, if the patient is seen early, treatment should be instituted as outlined above, though at this stage emptying of the uterus by hysterotomy might be preferable to an abortion. Late in the second trimester, viability becomes a factor. Radium may be applied to the cervical lesion by plaque or colpostat, and then, when viability has been attained, cesarean section may be performed. Following the section, radiation therapy—with both x-rays and intercavitary radium—should be completed. In the third trimester, the indication is clear for immediate cesarean section, preferably by high laparotrachelotomy, followed by a full course of x-ray and radium therapy.

The first patient in the authors' series of 4 complained of pain and vaginal bleeding in the fifth month of gestation. A diagnosis of threatened abortion was made and after the subsidence of pain and bleeding the patient was discharged. When she was readmitted, ten days later, a polypoid bleeding mass was seen at the cervix. Local treatment with radium was followed by cesarean section and panhysterectomy. The original lesion was completely eradicated, but the patient died two years later with metastases in the iliac nodes.

The second patient, a 42-year-old woman with a history of eight previous pregnancies, was admitted in the sixth month of gestation, with a history of bleeding of four months duration. Vaginal examination revealed an indurated papillomatous mass protruding from the cervix. Cesarean section was done, followed by radium and roentgen therapy, but valuable time had been lost after the onset of vaginal bleeding, and the patient died within two years of discovery of the lesion.

The third patient was a 22-year-old woman complaining of vaginal bleeding of three weeks duration. A recent pregnancy, complicated by bleeding for two or three days in the fourth month of gestation, had terminated in premature labor and delivery at seven months, three months prior to the present admission. A presumptive diagnosis of retained secundines was made. Examination revealed cervical carcinoma, probably present during the pregnancy. In spite of radium and roentgen therapy the course was rapidly downhill.

The fourth case is that of a 19-year-old patient who was examined some twelve hours after labor had started because progress was not satisfactory, and a cervical irregularity was noted on rectal examination. Vaginal examination revealed a hard, indurated margin, extending halfway around a partially dilated cervical os. The fetus was delivered by a high laparotrachelotomy. Roentgen therapy brought about only temporary improvement, and at the time of the report extensive recurrence was evident.

The authors regret the hesitancy with which adequate examination is undertaken during pregnancy. They believe that the gravid patient with vaginal bleeding should be accorded the same diagnostic procedures that one would unhesitatingly use in the non-gravid.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Estimation of Dose from Radiation Applicators Used in the Treatment of Carcinoma of the Uterine Cervix. Walter Gaines and Norman E. Scofield. West. J. Surg. **59:** 71–75, February 1951.

A change in radium distribution in applicators for the cervix uteri used at the University of California Hospital necessitated dosage calculation in gamma roentgens for various physical distributions of the radium. Applicators consisted of a cervical canal tandem tube in 3 sections, one round cervical plaque, and a square cervical plaque. Loading of the stem piece was 1 to 3 tubes of 25 mg. each. The cervical plaques were loaded with 3 or 4 12.5-mg. tubes. With the anatomical points described by Tod and an arbitrary time of fifty-four hours the delivered dose was found to range from 1,000 to 5,150 gamma roentgens at Point A (2 cm. lateral to the central canal of the uterus and 2 cm. up from the mucosa of the lateral fornix); 470 to 1,012 gamma roentgens at Point B (a point 3 cm. lateral to Point A, approximately the level of the obturator node), and from 1,755 to 12,150 gamma roentgens at an arbitrary point within the cervical lip. The discrepancy between "milligram hours" as a statement of dose and the actual delivered dose within points of the tumor bed is reiterated and demonstrated.

Seven figures.

EARL R. HAYNES, M.D.
The Henry Ford Hospital

Supraspinatus Tendinitis: A Survey of 300 Consecutive Cases Treated by Roentgen Therapy. Oliver T. Steen and J. A. L. McCullough. Am. J. Roentgenol. **65:** 245–254, February 1951.

The frequency of supraspinatus tendinitis is such that it is considered to be the commonest cause of shoulder pain. While the discomfort and disturbance of function are related to the shoulder joint, the lesion is entirely extrinsic to the joint proper. It is thought that the lesion starts as a degenerative process in the tendon fibers. Relatively early aging processes occur in this area which are believed to have a mechanical basis of origin, and it is probable that this is related to poor anatomical and functional adaptation.

Following the initial phase of degeneration in the tendon fibers there occurs a non-suppurative foreign-body reaction with removal of the devitalized material.

The inflammation gradually extends into the tendon sheath and often into the overlying bursa and surrounding soft tissues. The degenerative lesion is irreversible, while the inflammatory reaction is reversible and tends to subside slowly, spontaneously. There are apt to be recurring episodes which always produce some degree of residual fibrosis. Calcific deposits are an interesting feature of the degenerative process, although the degenerative inflammatory process may be present without a demonstrable calcium deposit. Conversely, there may be a calcium deposit present in a degenerative area of the tendon without the symptoms of inflammation. The formation of the calcium deposit is usually explained on the theory of faulty oxidation in devitalized tissue with a reduction of the formation of carbon dioxide locally and consequent shift of the pH toward the alkaline side. This favors the precipitation of calcium salts.

The diagnosis of supraspinatus tendinitis is based on the case history and the physical examination, supplemented if possible by roentgenograms of the shoulder girdle. The presenting signs and symptoms are pain in the shoulder and limitation of movement. There may be a history of trauma, but this is often vague, and at least two-thirds of the patients give no history of any trauma. Roentgen examination is recommended in all cases, since the presence of the calcium deposit is strongly supportive evidence of the presence of this lesion when combined with a suggestive history and physical examination.

The authors have based this report on 300 consecutive cases treated by external roentgen radiation. The object of such therapy is the effect produced on the inflammatory phase of the lesion and not on the degenerative process. Their initial course of roentgen therapy consisted of four consecutive daily applications of 150 r (in air) directed to the point of maximum tenderness through a 10 × 10-cm. port. The physical factors were: 200 kv., 0.5 mm. Cu plus 1 mm. Al added filtration, 50 cm. distance.

In interpreting their results the authors employed a broad classification of favorable and unfavorable. The favorable group included those patients who were considered to have received sufficient benefit within a period of three weeks following treatment; and the unfavorable those who received only slight benefit or no benefit at all.

In the entire series of cases the authors obtained 83.6 per cent favorable results, which they further subdivide according to general classification of patients. Their lowest percentage of favorable results (73 per cent) was obtained in 31 patients who had had some type of therapy other than roentgen therapy prior to the initiation of treatment.

There is a slight predominance of females in the series reported here, 51.4 per cent. There were 160 lesions of the right side as against 140 on the left side. The average age of the patients was 50.4 years for males and 50.6 years for females. Thirty-nine per cent of the patients had return of symptoms after one course of therapy and were subsequently treated by a second series. The average number of treatment courses was 1.5 for the entire series.

Three roentgenograms; 1 chart; 2 tables.

JAMES W. NELSON, M.D.
University of Arkansas

RADIOISOTOPES

Treatment of Polycythemia Vera with Radioactive Phosphorus. Bruce K. Wiseman, Robert J. Rohn, Bertha A. Bouroncle, and William G. Myers. Ann. Int. Med. **34**: 311–330, February 1951.

The authors report their experience with radioactive phosphorus in the treatment of 108 cases of polycythemia vera, extending over a period of almost ten years.

Essentially, the object of treatment of polycythemia is control of the excessive hyperplasia of all the marrow elements with minimal danger, discomfort, and expense to the patient. By control of blood platelet levels, the morbidity incident to arterial thrombosis in this disease is reduced; by control of excessive leukocytosis, the attendant symptoms of excessive splenomegaly and hepatomegaly are relieved and progression to chronic myeloid leukemia is averted; by control of red blood cell levels, freedom from symptoms due to sluggish circulation may be expected. The use of radiophosphorus was found to fulfil the hematologic and clinical requirements completely and safely.

The oral method of administration of the isotope, in the fasting state, has been as satisfactory as parenteral methods. Safety in the use of materials for internal radiation effects depends in substantial part upon the accuracy of standardization of radioactivity.

The therapeutic effect with reference to red blood cells of a given dose of radiophosphorus cannot be evaluated for a period of at least two months, since a reduction of circulating red cells is effected by decreasing the rate of their formation by partial suppression of erythrogenesis. Individual differences exist in tolerance by the bone marrow to equivalent doses of P^{32}. A few cases are so resistant to radiation effects that they are best treated by conventional methods. Nearly all the authors' patients received complete relief of symptoms except pruritus. At least 80 per cent were restored subjectively to normal and most of the remainder to near normal.

The physical signs of this disease are uniformly treated successfully with radiophosphate. Splenomegaly is shown to be the most difficult sign to erase completely. This may be due to permanence of enlargement of this organ from infarctions occurring previous to irradiation treatment or possibly, in some cases, to the advent of myelosclerosis.

The bone marrow findings before and after treatment with radiophosphate are considered inadequate for satisfactory interpretation.

The life history of this disease when untreated, particularly with respect to longevity, is unknown. None of the various methods of therapy currently used, including P^{32}, can be shown to decrease the prospective life span.

Of 453 patients reported as presently or in the past under treatment with P^{32} for polycythemia, in various institutions, 8.8 per cent have died. About one-third of these have died of an acute form of leukemia. None has died of a chronic leukemia, although this termination was quite common, probably in at least 20 per cent, in groups not treated by radiation methods. The induction of malignant changes by P^{32} therapy in vis-

ceral structures other than bone marrow does not occur, at least as a cause of death, in patients of the age range involved.

Deaths from arterial thrombosis do not seem to show any significant variation in the cases treated by P^{32} and those by other methods, or, as a matter of fact, in the general population of this age range without polycythemia vera.

Eight tables; 7 graphs.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Studies of Radiogallium as a Diagnostic Agent in Bone Tumors. W. C. Mulry and H. C. Dudley. J. Lab. & Clin. Med. **37**: 239–252, February 1951.

This report deals with the first 18 persons with primary and secondary bone neoplasms in whom radiogallium tracer studies were made at the Naval Medical Research Institute, Bethesda, Md. The purpose of the study was (*a*) to develop methods for the localization of Ga^{72} in the human body, by an externally positioned Geiger tube, and (*b*) to determine the degree of localization of Ga^{72} in patients with neoplastic lesions involving bone.

Gallium is a metallic element having many of the chemical properties of aluminum. The radioactive isotope (Ga^{72}) is a beta and gamma emitter, of energetic spectrum (max. β 3.1 mev, γ 2.5 mev). The isotope is contained in carrier gallium (0.1 mc. per milligram Ga) and administered as the citrate.

Geiger counting technic applied to the skin surface of human beings was found to be useful for the localization of radiogallium (Ga^{72}) citrate in osteoid structures. The intravenous tracer doses of the radiogallium were found selectively concentrated in the osteoid lesions, both osteogenic and osteolytic, in 15 of the 18 cases of bone neoplasm studied. The concentration of Ga^{72} in malignant neoplasms involving bone approaches twenty times that found in the adjacent bone.

Early metastases to bone have been identified through the use of tracer amounts of Ga^{72} before changes could be identified roentgenographically.

Five figures; 1 table.

[An experimental study in which radiogallium was shown to concentrate at areas of osteogenic activity has appeared in RADIOLOGY (Dudley, Imirie, and Istock: Deposition of Radiogallium (Ga^{72}) in Proliferating Tissues. Radiology **55**: 571, October 1950).—Ed.]

Practical Physical Aspects in the Use of Radioactive Cobalt 60 as a Radium Substitute. Isadore Meschan, Raymond R. Edwards, and Paul Rosenbaum. Am. J. Roentgenol. **65**: 255–264, February 1951.

A cheap, stable, readily available method for encasing pure cobalt wire is described which utilizes hyperchrome steel tubing, 16 gauge, for the 1 mm. wire. Cobalt 60 needles can therefore be obtained in any length and, indeed, in any desired shape for which the hyperchrome steel tubing is applicable. The hyperchrome steel is procurable by the foot from the Becton-Dickinson Co., Rutherford, N. J. The steel is resistant to body tissue fluids, and produced no significant reaction when implanted interstitially in rabbits.

A discussion of the gamma roentgen equivalence of radium and cobalt 60 is presented and it is indicated that for all practical purposes, with a thin filter for cobalt 60, such as 0.23 mm. hyperchrome steel, the ratio is: *Cobalt: Radium = 1.3: 0.84* or $K = 0.646$. This ratio has been applied to Paterson-Parker charts for utilization of the established methods, and these new graphs are presented in the article. A sample calculation for a uniplanar implant is likewise given.

The problem of standardization of cobalt 60 is also discussed.

Four figures; 4 tables.

I. MESCHAN, M.D.
University of Arkansas

Radiocobalt in Otolaryngology. Lewis F. Morrison. Arch. Otolaryng. **53**: 153–158, February 1951.

This delightfully readable report on radiocobalt, from the University of California Medical School, presents interesting and general facts about this metal. As a radio-inactive metal, cobalt is obtainable in adequate supply, relatively free of contaminants, and can be fabricated into any form or shape. When it is radioactive, its gamma radiation is of higher energy than that of radium. Beta radiation constitutes only 4 per cent of the total energy emission and requires only a thin plate of silver for its elimination. Radioactive cobalt is available from the neutron reactor in any desired quantity and its activity can be increased by special irradiation. Any cobalt that enters the body can be rapidly eliminated. It is relatively cheap. Its single disadvantage, as compared to radium, is its relatively short half life, 5.3 years.

Radiocobalt has been used in treating 11 patients with radiosensitive malignant neoplasms of the maxillary sinus, the nasal septum, and nasopharynx. The initial local reaction was the same as with similar doses of radium. The long-term results remain to be seen.

Two illustrations.

PAUL W. ROMAN, M.D.
Baltimore, Md

Excretion of Radioactivity During a Four-Day Period Following the Feeding of Carbon 14-Labeled 2-Acetylaminofluorene to Rats. John H. Weisburger, Elizabeth K. Weisburger, and Harold P. Morris. J. Nat. Cancer Inst. **11**: 797–803, February 1951.

The authors report the distribution and metabolism of carbon 14-labeled 2-acetylaminofluorene, a carcinogen, in rats over a period of approximately four days.

A single dose of ring-labeled and side-chain-labeled 2-acetylaminofluorene was used in young female Buffalo rats, with a dosage of 10 mg. per 100 gm. of body weight, the material being dissolved in a solution of propylene glycol and given via stomach tube. The animals were placed in metabolism cages and the respired carbon dioxide, urine, and feces were collected over a period of ninety-six hours, after which time the animals were killed and the more important organs and tissues were submitted to radio-assay.

The results indicated that the breath of the animals contained insignificant amounts of radioactivity after feeding of the side-chain-labeled carcinogen, while more than 40 per cent was found after feeding of the ring-labeled material. The urine accounted for 36.5 per cent of the side-chain-labeled material and 63.8 per cent of the ring-labeled compounds. It was also found that the feces contained 28.6 per cent of the recovered radioactivity from the side-chain-labeled material. This is reported as the first evidence of the feces containing important metabolites no longer diazotizable.

Two tables.

H. D. KERMAN, M.D.
Oak Ridge Institute

EFFECTS OF RADIATION

Acute Radiation Syndrome. A Problem for Practitioners. John Z. Bowers. J. A. M. A. **145:** 63–65, Jan. 13, 1951.

The acute radiation syndrome is defined as being "caused by the exposure of the whole body to damaging amounts of penetrating radiation, resulting in acute degenerative changes in the blood and blood-forming organs, the blood vessels and the bowel, and characterized clinically by prostration, a hemorrhagic diathesis, nausea, vomiting, diarrhea, and epilation. The treatment is at this date supportive, and the outcome without treatment is often fatal."

The primary effect of radiation on the cells is a cessation of mitotic activity. The cells die and are not replaced. In the case of leukopoietic tissues this results in a leukopenia in twenty-four hours. The erythrocyte has a life span of about one-hundred days, so that anemia appears much later. The mucosa of the gastro-intestinal tract shows ulceration of varying degrees.

There are three forms of the syndrome:

1. The fulminating form, resulting in death in seven to ten days.
2. The hemorrhagic form, with death in three to four weeks, in a lesser percentage of persons affected. These patients have nausea, vomiting, and diarrhea for twenty-four hours, are then well for ten days to two weeks, after which hemorrhagic phenomena appear.
3. The pancytopenic form occurs in persons less severely exposed. The initial symptoms are mild, but in three to five weeks gastro-intestinal and hematologic symptoms appear. Most of the deaths are due to aplastic anemia, but many in this group recover.

The article is intended to make the practitioner familiar with the syndrome produced by sudden exposure to the penetrating radiations liberated by the atomic bomb.

PAUL W. ROMAN, M.D.
Baltimore, Md.

Medical Problems in Atomic Warfare. James P. Cooney. New York State J. Med. **51:** 239–244, Jan. 15, 1951.

Casualties from an atomic explosion are divided into three categories: blast, burns, and radiation. Blast effects are apparently rather insignificant. Burns offer the greatest source of casualties. Deaths due to ionizing radiation accounted for approximately 15 per cent of the fatalities at Hiroshima. Radiations are classified as prompt, delayed, residual, and induced, of which the delayed radiations are of most concern.

Consideration of ionizing radiations is of less importance in preparing defense for atomic explosion, since the majority of the casualties are the result of blast and burn effect. The most severe atomic explosion catastrophe would seem to result from an air burst.

Four figures.

JOHN F. RIESSER, M.D.
The Henry Ford Hospital

Effect of X-Irradiation on Erythrogenesis, Plasma and Cell Volumes. Jacob Furth, G. A. Andrews, R. H. Storey, and Leon Wish. South. M. J. **44:** 85–92, February 1951.

The authors discuss the pathogenesis of post-irradiation anemia. Studies were performed on mice and rabbits exposed to a dose of x-rays lethal to 50 per cent of the animals. Both the erythrocyte count and mass and plasma volume were studied.

After massive irradiation, erythrogenesis ceases almost immediately and is not resumed until after seven to fourteen days. During this time there is a fall in total red cell mass. This fall is due to (*a*) death of normally aging red cells with a cessation of new cell formation, (*b*) to loss of red cells caused by heightened capillary permeability, and (*c*) possibly to other factors hitherto not recognized. Simultaneous changes in plasma volume mask the magnitude of drop in erythrocyte mass. Phagocytic reticulo-endothelial function is not markedly altered by irradiation.

The hypothesis is advanced that continuous leakage of erythrocytes through damaged endothelium to tissue spaces and lymph channels is a major factor in the causation of post-irradiation shock and anemia.

Five graphs; 3 photomicrographs.

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Effect of Ionizing Radiations on the Broad Bean Root. Part VIII. Growth Rate Studies and Histological Analyses. L. H. Gray and M. E. Scholes. Brit. J. Radiol. **24:** 82–92, February 1951; 176–180, March 1951; 228–236, April 1951; 285–291, May 1951; 348–352, June 1951.

Broad bean (*Vicia faba*) roots were irradiated with varying dosages as follows: gamma rays up to 250 r, x-rays up to 140 r, and alpha rays up to 36 equivalent r.

Inhibition of growth caused by both gamma and x-radiation is dependent upon the duration of the exposure. Alpha ray inhibition is independent of time between ten minutes and twenty-four hours.

The greatest effect, which occurs about six days after the irradiation, is related exponentially to the alpha ray dose and to the gamma and x-ray doses when given in twelve to twenty-four hours.

Detailed studies of histologic changes were made of the roots irradiated with 140 r of x-rays. These indicate that chromosomal damage accounts for most of the inhibition of growth.

Thirty-one figures; 1 plate; 4 tables.

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Histological and Cytological Changes Produced by Alpha-Particles in the Skin of Mice. Finn Devik. Acta radiol. **35:** 149–164, February-March 1951.

The histological and cytological effects of alpha rays from polonium on the skin were investigated in 84 mice of a recessive hairless strain. Five different dosages of irradiation were given, and histologic sections were made at intervals up to twenty days after the irradiation. In the investigation the range of the alpha particles was assumed to be 37μ in tissue, which represents more than the thickness of the epidermis.

The ionization caused by the alpha particles from the polonium preparation (10 millicuries Po spread on a square nickel sheet, 1 cm.^{2}) was determined in an ionization chamber, the preparation being screened by aluminum foils of varying thickness. From these observa-

tions the different depth doses were calculated and expressed in roentgens.

The effects of the alpha rays, which are localized mainly to the epidermis, are compared to the effects produced by roentgen rays in the skin. The "indirect effects" brought about by the connective tissue seem to be of major importance in the skin reaction following roentgen irradiation.

It was found that many of the cells in the epidermis will survive doses of the order of 100,000 roentgens (alpha rays).

Mitotic activity is suppressed for one to two days after alpha irradiation. The characteristic cytologic changes seen in mitosis after roentgen irradiation—chromosome fragments, "bridges," and cells with micronuclei—were only occasionally observed after alpha irradiation.

The author belives that the heavy doses of alpha rays administered to the epidermis probably do not cause production of freely diffusible toxic substances in any noticeable amounts.

Fourteen figures, including 12 photomicrographs.

Splanchnic Removal of Bacteria from the Circulating Blood of Irradiated Rabbits. J. Lamar Callaway and Grace P. Kerby. Arch. Dermat. & Syph. **63**: 200–204, February 1951.

The exact mechanism of splanchnic removal of bacteria from the blood stream is unknown, although it is believed to be a function of the reticulo-endothelial system. In order to study the effect of irradiation (to which the reticulo-endothelial system is believed to be particularly susceptible) on this mechanism, the following experiments were done:

1. Bacteremia was induced in rabbits (1) by continuous infusion of *Staph. aureus* into the superior vena cava and (2) by injecting pneumococci into the skin, causing a dermatitis which gave rise to a bacteremia.

2. The *Staph. aureus* bacteremia group was irradiated as follows: (A) Five rabbits received 100 r (h.v.l. 0.5 mm. Cu) to the right thigh forty-eight hours before the induction of the infection. (B) One rabbit received 800 r (h.v.l. 0.5 mm. Cu) to the liver and spleen area of the upper abdomen fifty-six hours before induction of the bacteremia. (C) Nine rabbits received total body irradiation of 800 r (h.v.l. 1.0 mm. Cu), and *Staph. aureus* bacteremia was induced at intervals ranging from two to thirty days later.

3. The pneumococcus bacteremia group was irradiated in the following manner: (A) Three rabbits received 200 r of radiation (h.v.l. 0.5 mm. Cu) to the anterior abdomen two, four, and six hours after intradermal injection of bacteria into this area. Splanchnic removal studies were done twenty-four and twenty-nine hours after injection. (B) Seventeen rabbits received 500 r (h.v.l. 0.85 mm. Al) to the bacterial injection site two hours after injection. Splanchnic removal studies were done twenty-three to twenty-nine hours later. (C) Three rabbits received 500 r (h.v.l. 0.85 mm. Al) to the injection site just before injection of the bacteria. Twenty-four hours later the intracardiac bacterial levels were studied in this group as well as in a control group not receiving radiation.

Blood samples were studied to determine if local or total body irradiation affected the ability of the splanchnic area to clear the blood of bacteria. No effect was noted.

The course of a secondary pneumococcic bacteremia was unaltered by irradiation of the dermal infection site either before or after the induction of the local infection.

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